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THE EXPANDING RELATIONS OF CHEMISTRY IN AMERICA[1]

AFTER a year of such strenuous service as characterized that through which we have just passed, it is well that we are again assembled for report on the work of our laboratories and for helpful conference concerning future growth and broader service. A large part of the past year's work has, through the suddenness of the call, been necessarily individualistic; the assemblage of this week furnishes the means for planning more coordinated effort for mutual counsel and for deepening that spirit of cooperation which is so essential if we are to worthily meet our full responsibilities.

It is again incumbent upon me to address you. In seeking a subject I have put aside the temptation to lay before you statistics illustrative of marvelous growth during the past year, and, in spite of our belief in specialization, it has not seemed suitable to select any one line of development for tracing in thorough detail. This period is still too formative and the demands upon you too many-sided for such restricted discussion. I have therefore selected the broader topic "The Expanding Relations of Chemistry in America," using the present participle advisedly as indicative of growth and as mandatory of greater effort if the widening circles of chemical influence are to reach the broad shores of full-fledged accomplishment.

The dynamic center of this movement is

[1] Address of the President of the American Chemical Society read at the New York meeting, September 26, 1916.

the American Chemical Society, which now consists of 8,136 members, a net growth of more than one thousand during the year just ended. This splendid growth is not only a tribute to the energetic activities of our efficient secretary, but is an evidence of increased activity in chemistry and of a quickened realization of the need of the strongest possible national organization. The strength of this organization, however, is not measured so much by numbers as by the loyal and unselfish response of its members to every call made in its name. To this I can abundantly testify.

In considering the expanding relations of chemistry in America let me group these under four heads—the relations to university administrations, to the national government, to our daily needs and to national thought.

RELATIONS TO UNIVERSITY ADMINISTRATIONS

Without doubt university executives have gained during the past year a clearer conception of the fundamental value of chemistry to the nation. Aside from our own exhortations, this conception has been easy of obtainment through the increased publicity given by the daily press and by periodicals to matters chemical, through the difficulty of purchase of certain needed supplies, through the feverish activity to meet these unexpected demands, and through the call for young chemists from university laboratories. Has the conception, however, been translated by the makers of university budgets into deeds which will insure an adequate response by the universities to the increased demand which is to be made upon them for chemists possessed of the best possible training? I have neither purpose nor desire to criticize, nor even to attempt answer, but I do not hesitate to suggest that in these abnormal times the demands upon chemistry departments are unusually great and should be generously met if we are to view the future with equanimity. The bounds of the service of chemistry to the nation are prescribed by the character and extent of the training given in our universities. Physical equipment must be increased and bettered, and staffs must be maintained adequate in number to allow full opportunity for research along with teaching duties.

The stimulus of these remarkable times upon the minds of the students is plainly evident, but here lies a danger. The expansion of existing industrial plants and the creation of new lines of endeavor in chemical industry call for many young men to serve in control work, and the call is often very alluring. It would be a great misfortune if the filling of these new positions should be at the expense of the graduate students of the future. We can not afford an abridgment of the number of young men thoroughly trained in our universities in the methods of research. Graduate fellowships in largely increased number should be provided, for without such aid the door of opportunity will be closed to many whose full mental potentialities will be needed in the future.

The danger of losses from university ranks, however, is not confined to graduate students: already there are strong indications of a considerable raid by the industries upon the staffs of universities, and the question of professorial emolument is therefore not one for leisurely future consideration, but belongs to the immediate present.

To sum up the university budget for chemistry needs prompt and decided expansion.

In the matter of cooperation between universities and industries definite progress has been made. Four important matters typify this progress.

The New York Section has conducted

throughout its winter meetings a symposium on this subject, and these discussions resulted in a request of the society that a permanent committee be appointed to carry forward vigorously such cooperation.

The General Chemical Company announced the formulation of a new policy in the creation of an advisory staff of university professors.

The Massachusetts Institute of Technology announced a master's course in chemical engineering, including a school of chemical engineering practise. Through the cooperation of industrial plants a half year of systematic plant experience and training is added to the curriculum without sacrifice of thorough foundation work or training in research. In return for the privileges offered by the plants, the research facilities and the faculty of the institute will be available for the study of special problems connected with each plant.

A joint meeting of the Puget Sound Section and the Seattle Chamber of Commerce aroused great enthusiasm and resulted immediately in the creation of industrial fellowships in the University of Washington for the study of the problems of the northwest.

Such illustrations furnish proof that earnest thought is being given to this phase of cooperation and it is inspiring to note how quickly such thoughts are being translated into definite action.

RELATIONS TO THE NATIONAL GOVERNMENT

Forty-nine members of the society, representing the several states and Alaska, on appointment, responded to the request of the President of the United States that the chemical industries be mobilized under the program of the organization for industrial preparedness. Publication of the correspondence in connection with these appointments would furnish lasting testimony to the loyal and unselfish patriotism of the membership of our organization.

In response to the invitation of the National Academy of Sciences our representatives are now cooperating in the organization of the research facilities of the nation and in questions connected with the establishment of the government nitrate plant.

If we are to promptly and intelligently proceed with the development of a diversified and comprehensive chemical industry we must know the detailed character and amounts of chemical importations. The statistics now published by the government are inadequate in their itemization. The formulation of the character of the information needed is our responsibility. This is the work of the committee on government statistics, of which committee Dr. B. C. Hesse is chairman. The inauguration of the work has unfortunately but necessarily been delayed. It is now well under way, and for its full consummation I beg to urge the thoughtful aid of every member of the society, and the cooperation of each of the local sections. We have never undertaken any more important or fundamental work than this. If, as a result of this inventory, we are able to state in exact terms the specific character of the information needed by the chemical industries, in order to render this country independent of foreign sources of supply, we will then have a right to expect with confidence the sympathetic cooperation of the federal authorities.

May I, under this heading, make two suggestions to the national authorities:

First, Provision should be made in the immediate future for the storage of large quantities of government-owned toluene. With the cessation of European war orders for explosives, and with the rapid increase of by-product retort ovens for coke manufacture we will eventually have a large over-production of toluene, with conse-

quent lowering of price. The potential value of this hydrocarbon in munitions is too great to allow its sacrifice as a fuel or as an illuminant, and its storage involves no unusual difficulties. The moral effect alone of its known presence in our midst would in itself justify the investment as a preparedness measure.

Second, Modern warfare is largely dependent upon the successful work of chemists, not alone in the direct production of munitions, but, through research, in husbanding the resources of the country, and in increasing knowledge which in times of stress may be vital to the nation. In view of the now well recognized fundamental character of such work the military authorities should formulate a definite policy in regard to the chemist, whereby in times of war his services may best be applied to the advantage of his country. The lack of such a policy during the recent enlistment of the National Guard has in several cases interrupted lines of research whose successful outcome would prove much more vital to the power of the army than the presence of the individuals bearing arms. England somewhat tardily recognized that her chemists were more needed at home than at the front and therefore recalled them.

Relations to our Daily Needs

The economic developments of the past two years have emphasized the close relation between normal daily needs and the activity of chemists, particularly through certain shortages which have brought economic distress. Among these shortages three stand out preeminent—motor fuel, potash for fertilizer and coal tar products, particularly synthetic dye-stuffs. Let me discuss the first and second of these briefly and the third somewhat more at length.

Motor Fuel.—The enormous annual increase of motors using gasoline as fuel, together with the largely increased export of this material, has resulted in greatly increased price of this product. To meet the situation chemists have naturally turned their attention to the "cracking" of the residues of crude petroleum, furnishing thus some relief. In view, however, of the uncertainty of petroleum supply such efforts can not prove the ultimate solution of the problem. With the cessation of the war further aid may be expected from the benzol recovered in the by-product coke oven plants. With this at its maximum, however, it is estimated that it would equal only ten per cent. of the motor fuel now consumed. Plainly we must look further for the permanent supply, and that seems to me to be alcohol. I am fully aware that there is nothing original in this suggestion. It is mentioned rather for the purpose of urging greater consideration of the problem by chemists, who must solve the problem, by manufacturers of motors who have such great interests at stake, and by lumbermen who, in their mill waste alone, possess the raw material from which, by processes in operation to-day, alcohol could be produced equal in volume to forty per cent. of our present gasoline consumption.

What striking advance in this line could be confidently expected if the automobile manufacturers and lumbermen of the nation would join forces with chemists in the creation of a great research laboratory where the problems of motor fuel could be vigorously attacked, not by the "green powder" method of recent notoriety, but by common sense, scientific investigation, conducted by the ablest of chemists and chemical engineers, unfettered by tradition and filled with the conviction that the day of genuine new things will never end.

Potash.—To meet our present shortage of this valuable fertilizer constituent we

have sought relief feverishly through the kelp fields of the Pacific coast, the alunite deposits of Utah, the feldspars, blast furnace and cement works waste, and have as yet obtained but slight relief. Something noteworthy may yet result from these earnest efforts, especially through the aid of the appropriation of $175,000 by congress for further investigation of kelp, but at present we seem to have adopted the general policy of waiting until the war is ended.

Let me, in this connection, remind you of the old problem, namely, the rendering available *in situ* the potash now in the fields in the form of silicates. The records of the U. S. Bureau of Soils show that the average weight of a foot acre of the sandy soil of the cotton belt is 1,750 tons, and it contains an average of .1 of 1 per cent. potash, or $1\frac{3}{4}$ tons K_2O per acre, while the clay soils average in weight 2,000 tons per foot acre, and show an average potash content of 1.68 per cent. or 33.6 tons K_2O per acre. From this material nature slowly supplies available potash for plant food through the action of the soil solution upon the potash-bearing silicates, but the process is too slow. Many lines of research are in daily progress in our laboratories whose object is the discovery of "accelerants" for certain chemical reactions. Does not the importance of this problem and its altogether normal character demand of us greater effort to find a suitable accelerant for this world wide process. The problem is easy to state, its solution has as yet proved impracticable. May we not hope that the activities of physical chemists through studies of the soil solution and its action upon the mineral constituents of the soil will ultimately be successful?

Coal Tar Dyestuffs.—It is unnecessary for me to remind you at this time of the great disturbance of our industrial life which resulted from the cessation of imports of German dyestuffs, nor of the rapid extension of the by-product coke oven whereby we are now assured of a far more than adequate supply of raw material for an American dyestuff industry sufficient for American needs. It is a pleasure to testify to the energy and resourcefulness of our dyestuff manufacturers who, in spite of competition with the munitions industry for coal tar crudes and for necessary acids and with uncertainty as to the future constantly dogging their steps, nevertheless, have notably contributed to the relief of the dyestuff famine.

It is my purpose, however, to trace, for the sake of the record, the efforts made during the past two years to obtain legislative assurance of a fair start in the upbuilding of a well-rounded permanent industry, and to point out the character of the legislation which on the last day of the present session of congress became a law of the land. It is a distressing story, humiliating to all who wish for our country freedom in every possible form. Here is the story.

Immediately after the outbreak of the war the New York Section of this society, foreseeing economic distress from possible shortage of dyestuffs, appointed a representative and politically non-partisan committee to report on the prerequisites of an adequate self-contained American dyestuff industry. The report, unanimously adopted by this the largest of our local sections, recommended congressional enactment of protective duties amounting to thirty per cent. ad valorem and $7\frac{1}{2}$ cents per pound specific on finished dyestuffs, one half these amounts on intermediates and an effective anti-dumping clause. The protective rates of this report formed the basis of the Hill bill, introduced in the house on the opening day of Congress by

Representative Ebenezer J. Hill, of Connecticut. In January, 1915, hearings were held on this bill and there was presented the unusual sight of both producers and consumers urging the Ways and Means Committee to report the bill favorably. In spite of this unanimity the report was not forthcoming. Public demand for such legislation, however, increased and finally, after a conference between leading members of the controlling party in both the Senate and the House of Representatives of a large number of producers and consumers, a form of legislation was proposed by the congressional representatives which embodied the ad valorem rates of the New York Section but reduced the specific duties by one third, such specific duties to continue in full force for a period of only five years, after which time they were to decrease twenty per cent. annually. Another feature was the proviso that if at the expiration of five years American dyestuff factories were not producing sixty per cent. of the values (note this carefully) of American consumption, the specific duties were to be immediately and completely repealed by Presidential proclamation.

In spite of the lowered specific duties this agreement, confirmed by authorized interviews from Washington, led to increased activity by many producers. It is not difficult to imagine, therefore, the amazed surprise which greeted the appearance of the dyestuff section of the general revenue bill, which, while it contained all of the above, showed one other totally unexpected feature, namely, the exclusion of indigo and alizarin and their derivatives from the benefit of the special duty of 5 cents per pound. Such an exception was fatal to the purposes of the bill. The *ad valorem* duty alone would not suffice to promote and encourage the manufacture of synthetic indigo and alizarin. No scientific or technical justification existed for discrimination against these two coal tar dyes, which constitute 29 per cent. of the values of our consumption. Furthermore, the manufacture of at least 10 per cent. of dyestuffs could not for the present be attempted in this country because of existing foreign patents. Such considerations show that the possibility of expansion of the home industry within the five-year period to 60 per cent. of the values of consumption would be precluded by the terms of the bill itself. Consequently the duration of the special duty for any dyestuff would be restricted to the initial five-year period. Evidently our lawmakers had surpassed the skill of the alchemists, in that they had demonstrated their ability to transform at least bricks into gold.

Pressed for a justification of the exclusion of indigo and alizarin, the chairman of the Ways and Means Committee made explanation on the floor of the house in a speech which by previous agreement was to conclude the debate. In this speech reference was made to the satisfactory character of the conference with the representatives of the industries; individual manufacturers were referred to as not desiring full protection for indigo and alizarin; and no justification on scientific or technical grounds was attempted. Then the dyestuff section of the bill was adopted by a party vote. Immediately briefs were filed with the subcommittee of the Senate Committee on Finance in charge of this section of the House bill. These briefs included letters and telegrams from the individuals referred to in the house debate refuting the statements made by the chairman of the Ways and Means Committee. Moreover they pointed out clearly that the exception of indigo and alizarin was not in accordance with the original conference agreement and would prove disastrous to the entire industry. The Senate subcommittee

was convinced and accordingly struck from the bill the objectionable exceptions and in addition included natural indigo and coal-tar medicinals and flavors, additions in every sense logical, and giving to the classifications of the bill a thoroughly comprehensive character.

With the appearance of the printed hearings and briefs an interesting exhibit was made by the plea of a large consumer of indigo located at Greensboro, North Carolina. Not content with the discrimination given indigo in the measure as passed by the house, he urged its complete removal to the free list. No other consumer of indigo joined in this request. The subcommittee rejected his plea.

The completed section of the revenue bill was then endorsed by the full committee and by the majority-party conference, and was adopted by the senate. In the last hours of the session the section emerged from the joint conference of the majority-party conferees from both senate and house with indigo and alizarin excluded from the special duty, and carrying along with them, as a sort of legislative by-product, medicinals and flavors. As no record is published of the proceedings of conference committees we are left to assumptions as to the influence which prevailed to give the section its final form; but in the light of the history of the legislation and the personnel of the conferees, as published in the *Congressional Record*, it is not difficult to imagine whose influence was determinative in maintaining the discriminatory feature of the original house legislation, against which united protest had been made save for the voice of one consumer. The section in this disastrous form was then adopted by both senate and house and is now the law.

Such is the answer of the present congress to the nation-wide (with one exception) call for adequate protective duties for the encouragement and upbuilding of this much needed industry. The claims of this industry, upon non-partisan legislative aid are reasonable, because of initial difficulties in manufacture and the character of the competition to be met after the war. These claims are also commanding, through the intimate connection of the industry with adequate munitions for our army and navy. Nevertheless, the measure professedly enacted for its upbuilding stands to-day stamped with the evidence either of the most specialized form of legislation for special interests; or of stupidity, as a tax placed upon the consumer without the benefit of an assured home industry; or of stubborness in maintaining a wrong position rather than admit an error in judgment. I do not believe the citizens of this nation will set the seal of their approval upon such legislation.

RELATIONS TO NATIONAL THOUGHT

In the light of the activities of the past year let us ask ourselves frankly—what is the position of chemistry to-day in the thought of the nation? No one can doubt that it occupies a much more prominent place. This is due in part to the superb response American chemists have given to the sudden call upon their resources and ingenuity, in part to the advertisement through the press of the important rôle of the German chemist in the industrial upbuilding of that nation, and to the constant repetition of the phrase that "modern war is largely a matter of chemistry and engineering."

Concrete evidence of increased appreciation of chemistry is furnished by the Second National Exposition of Chemical Industries now in progress. Its exhibitors are more than double those of last year; its exhibits show many new products, born of the exigencies of the year: its underlying thought has been broadened to include

a more systematic showing of the importance of chemistry to the wise use of natural resources; and its purposes have gained a far wider and more appreciative understanding by our people as a whole.

Again we find evidence in the recent issuance of a special chemistry edition by a prominent trade journal, *The Manufacturers Record*. The purpose of that unusual issue was not merely to emphasize the advantages of a great section of the country for the upbuilding of chemical industries, but of far greater importance it sought to vitalize the thought of the people of that section as to the fundamental character of chemistry among the factors of industrial development.

Furthermore, it must be noticeable to all that slowly but surely an educational campaign is getting under way in the daily press and in periodical literature which will eventually result in the arousal of our people to a full comprehension of the value of chemistry as a national asset.

These are simply signs of the times. We can not, however, feel that the national thought has as yet grasped in its entirety the all pervading influence of chemistry so long as Cornell University, with its strong chemistry staff, must delay the replacement of its burned laboratory through lack of funds; so long as Johns Hopkins University, the cradle of American chemical research, must undergo such struggle for the means to erect a new laboratory on the beautiful new site of that institution; so long as members of congress view chemists and chemical manufacturers as fit subjects for hard bargaining; so long as railway presidents feel that chemistry has no part in the development of the natural resources of the sections traversed by their lines; and so long as waste in any form is allowed to continue unheeded.

Further expansion of the relations of chemistry to the national thought involves—

First. Continued educational effort through the press. Plans for such are being evolved, and these plans are meeting the quickened sympathy of the leaders of the press. Each of us must cooperate in this work. As a class we are not qualified to write in popular style, and in the past we have not troubled ourselves very much about such matters; but we can furnish facts and sound opinion to those who have the work and responsibility of popular presentation, and we should stand ready, each in his own community, to share in such cooperative effort.

Second. An awakening of the financial interests of the country to the fact that the ways of chemistry are not mysterious but applied common sense which constitutes a sure guide.

Third. Continued worthiness of our own efforts. This is our direct responsibility. Thoroughness of training, untiring zeal in work, aggressive conservatism in counsel, courage in new undertakings, independence in thought, generous cooperation, constant search for truth—these must surely lead us to that vantage ground where we can best serve this our country.

Chas. H. Herty

ON THE ANALYSIS OF LIVING MATTER THROUGH ITS REACTIONS TO POISONS[1]

I am told that the chair of Section I has not been held by a pharmacologist for many years, and I wish to express the pleasure I feel in the honor that has been done me personally, and even more in the recognition vouchsafed to one of the youngest handmaidens of medicine. Pharmacology

[1] Address before the Physiological Section of the British Association for the Advancement of Science, Newcastle-on-Tyne, 1916.

has too often shared the fate of the bat in the fable: when we appeal for support to the clinicians we are told that we represent an experimental science, while when we attempt to ally ourselves with the physiologists we are sometimes given the cold shoulder as smacking too much of the clinic. As a matter of fact, we should have a footing in each camp, or, rather, in each division of the allied forces. And the more recent successes in the application of pharmacology to diseased conditions are now beginning to gain it a rather grudging recognition from clinicians, while the alliance with the biological sciences is being knit ever more closely. The effect of chemical agents in the living tissues has assumed a new and sinister aspect since the enemy has resorted to the wholesale use of poisons against our troops, but I must leave this for the discussion to-morrow.

I wish to-day to discuss an aspect of pharmacological investigation which has not been adequately recognized even by the pharmacologists themselves and which it is difficult to express in few words. In recent years great advances have been made in the chemical examination of the complex substances which make up the living organism, and still greater harvests are promised from these analytic methods in the future. But our progress so far shows that while general principles may be reached in this way, the chemistry of the living organ, like the rainbow's end, ever seems as distant as before. And, indeed, it is apparent that the chemistry of each cell, while possessing general resemblances, must differ in detail as long as the cell is alive. No chemistry dealing in grams, nor even microchemistry dealing in milligrams, will help us here. We must devise a technique dealing with millionths to advance towards the living organism. Here I like to think that our work in pharmacology may perhaps contribute its mite; perhaps the action of our drugs and poisons may be regarded as a sort of qualitative chemistry of living matter. For chemical investigation has very often started from the observation of some qualitative reaction, and not infrequently a good many properties of a new substance have been determined long before it has been possible to isolate it completely and to complete its analysis. For example, the substance known now as tryptophane was known to occur in certain substances and not in others long before Hopkins succeeded in presenting it in pure form. And in the same way it may be possible to determine the presence or absence of substances in living tissues, and even some of their properties, through their reaction to chemical reagents, that is, through the study of the pharmacology of these tissues. A simple example may render the point clearer: It is possible that if the toxicity of the saponins to different cells were accurately known, the relative importance of the lecithins in the life of these cells might be estimated, and this might give a hint to the chemist in approaching their analysis. I do not claim that pharmacological investigation can at present do much more than the qualitative testing of the tyro in the chemical laboratory, but even a small advance in the chemistry of living matter is worthy of more attention than this has received hitherto.

All forms of living matter to which they have free access are affected by certain poisons, and some of these have obvious chemical properties which suggest the method of their action; thus the effects of alkalies and acids and of protein precipitants hardly need discussion. Others such as quinine and prussic acid, which also affect most living tissues, have a more subtle action. Here it is believed that the common factor in living matter which is changed by these

poisons is the ferments, and quinine and prussic acid may therefore be regarded as qualitative tests for the presence of some ferments, notably those of oxidation, and, in fact, have been used to determine whether a change is fermentative in character or not. Formaldehyde was stated by Loew to be poisonous to living matter through its great affinity for the NH_2 group in the proteins, a suggestion which has perhaps not received enough attention of late years, during which the importance of this group in proteins has been demonstrated. The toxicity of other general poisons, such as cocaine, is more obscure. But what has been gained already in this direction encourages further investigation of the action of the so-called general protoplasm poisons and further efforts to associate it with the special constituents of the cell.

In other poisons the action on the central nervous system is the dominating feature, and among these the most interesting group is that of the simple bodies used as anesthetics and hypnotics, such as ether, chloroform and chloral. The important use of this group in practical medicine has perhaps obscured the fact that they act on other tissues besides the central nervous system, though we are reminded of it at too frequent intervals by accidents from anesthesia. But while they possess this general action, that on the nervous tissues is elicited more readily. Not only the nerve-cell, but also the nerve-fiber react to these poisons, as has been shown by Waller and others. And even the terminations are more susceptible than the tissues in which they are embedded, according to the observations of Gros. The selective action on the nervous tissues of this group of substances has been ascribed by Overton and Meyer to the richness in lipoid substances in the neurons, which leads to the accumulation of these poisons in them, while cells containing a lower proportion of lipoid are less affected. In other words, Overton and Meyer regard these drugs as a means of measuring the proportion of lipoids in the living cell. This very interesting view has been the subject of much discussion in recent years, and, in spite of the support given it by several ingenious series of experiments by Meyer and his associates, no longer receives general acceptance. Too many exceptions to the rule have to be explained before the action of these bodies can be attributed wholly to their coefficients of partition between lipoids and water. At the same time the evidence is sufficient to justify the statement that the property of leaving water for lipoid is an important factor in the action of the bodies, although other unknown properties are also involved in it. And whatever the mechanism of the characteristic action, these substances in certain concentrations may be regarded as tests for the presence of nervous structures and have been employed for this purpose.

Other bodies acting on the nervous system have a much narrower sphere. Morphine and strychnine, for example, appear to be limited to the region of the nerve-cells, but there is still doubt whether they affect the cell-body alone or the synapses between certain of its processes. They have not been shown to act on peripheral nervous structures in vertebrates, nor on any but specific regions of the central nervous system. Nor has it been established that they affect invertebrates. The substance with which they react is obviously limited by very narrow boundaries around the nerve-cell.

More interest has been displayed in recent years in the alkaloids which act on the extreme terminations of various groups of nerves. These are among the most specific reagents for certain forms of living matter which we possess. Thus, if an organ reacts

to adrenaline, we can infer that it contains the substance characteristic of the terminations of sympathetic fibers, with almost as great certainty as we infer the presence of a phenol group from the reaction with iron. And this sympathetic substance can be further analyzed into two parts by means of ergotoxine, which reacts with the substance of the motor sympathetic ends, while leaving that of the inhibitory terminations unaffected. Similarly the endings of the parasympathetic nerves are picked out with some exceptions by the groups represented by atropine and pilocarpine, and here again there must be some definite substance which can be detected by these reagents.

Further, some light has been thrown on, at any rate, one aspect of these nerve-end substances by the observation that they all react to only one optical isomer in each case. Thus the dextro-rotatory forms are ineffective in both atropine and adrenaline, and this suggests strongly that the reacting body in the nerve-ends affected by these is itself optically active, though whether it bears the same sign as the alkaloid is unknown. This very definite differentiation between two optical isomers is not characteristic of all forms of living matter. For example, the heart muscle seems to react equally to both lævo- and dextrocamphor. The central nervous system contains substances which react somewhat differently to the isomers of camphor and also of atropine, but the contrast is not drawn so sharply as that in the peripheral nerve-ends.

Another test alkaloid is curarine, the active principle of curare, which in certain concentrations selects the terminations of the motor nerves in striated muscle as definitely as any chemical test applied to determine the presence or absence of a metal.

The tyro in the chemical laboratory is not often fortunate enough to be able to determine his analysis with a single test. He finds, for example, that the addition of ammonium sulphide precipitates a considerable group of metals, which have then to be distinguished by a series of secondary reactions. The pharmacologist, as an explorer in the analysis of living matter, also finds that a single poison may affect a number of structures which appear to have no anatomical or physiological character in common. But as the chemist recognizes that the group of metals which react in the same way to his reagent have other points of resemblance, so perhaps we are justified in considering that the effects of our poison on apparently different organs indicate the presence of some substance or of related substances in them. A great number of instances of this kind could be given, and in many of these the similarity in reaction extends over a number of poisons, which strengthens the view that the different organs involved have some common reacting substance.

One of the most interesting of these is the common reaction of the ends of the motor nerves in striated muscle and of the peripheral ganglia of the autonomic system. It has long been known that curare and its allies act in small quantities on the terminations of the motor nerves in ordinary muscle, while larger amounts paralyze conduction through the autonomic ganglia. More recently it has been developed by the researches of Langley that nicotine and its allies, acting in small quantities on the ganglia, extend their activities to the motor ends in large doses. Some drugs occupy intermediate positions between nicotine and curare, so that it becomes difficult to assign them to either group. These observations appear to leave no question that there is some substance or aggregate common to the nerve-ends in striated muscle and to the autonomic ganglia. As to the exact anatomical position of this substance, there

is still some difference of opinion. Formerly it was localized in the terminations of the nervous fibers in the muscle and ganglia, but Langley has shown that in the latter the point of action lies in the ganglion-cell itself, and his researches on the antagonism of nicotine and curare in muscle appear to show that the reacting substance lies more peripherally than was supposed, perhaps midway between the anatomical termination of the nerve and the actual contractile substance. Another analogy in reaction has been shown to exist between the ganglia and the terminations of the post-ganglionic fibers of the parasympathetic, for Marshall and Dale have pointed out that a series of substances, such as tetramethyl-ammonium, affect each of these in varying degrees of intensity. The specific character of the reaction is shown by the fact that while it is possessed by the tetramethyl-ammonium salts, the tetraethyl-ammonium homologues are entirely devoid of it.

Another close relationship is shown by the reaction of the glucosides of the digitalis series on the heart and vessels. These all act on the muscle of the heart, and in higher concentration on that of the vessel-walls. There must therefore be a common base in these which is affected by the drugs. And the existence of this is perfectly intelligible in view of the fact that the heart is developed from the vessels. A more obscure relationship is shown by the reaction of this group to the inhibitory cardiac center in the medulla, which is thrown into abnormal activity by their presence in the blood, as has been shown alike by clinical and experimental observations. A similar relation is shown by the common reaction of the heart-muscle and the vagus center to aconitine and some other related alkaloids. On the other hand, the saponin series, which shows a closer relationship to the digitalis bodies in the heart-muscle, is devoid of its characteristic action on the medulla. The reacting substance in the heart is thus capable of responding to digitalis, saponin and aconitine, while that in the vagus center can associate only the first and last and is not affected by the saponins; the common reactions indicate that the two are related, while the distinctive effect of saponin shows that they are not identical. A similar relationship may be drawn from the action of morphine and the other opium alkaloids on pain sensation, on respiration, and on the movements of the alimentary tract. Exact determinations of the relative power of these alkaloids in these regions are not at our disposal as yet, but sufficient is known to suggest that while morphine affects a common substance in the medullary center and the intestinal wall, the other members of the series act more strongly in one or other position.

It was long ago pointed out that caffeine affects both kidney and muscle-cell, and Schmiedeberg has attempted to correlate the intensity of action of the purine bodies at these points and to measure the probable diuretic action by the actually observed effect on the contraction of muscle. Other reactions of the kidney suggest a relationship to the wall of the bowel. For example, many of the heavy metals and some other irritant bodies act strongly on the kidney and bowel, and again, according to one view of renal function, many of the simple salts of the alkalies affect the kidney in exactly the same way as the bowel-wall. This last may, however, be due to the physical properties of the salts, and the likeness in reaction to those of kidney and bowel, which is striking enough, may arise from a likeness in function of the epithelium rather than from any specific relationship to the salts which is not common to other forms of living matter.

Many other examples might be cited in which organs which are apparently not related, either morphologically or in function, react to poisons in quantities which are indifferent to the tissues in general. And this reaction in common can only be interpreted to mean that there is some substance or group of related substances common to these organs. The reaction may differ in character; thus a drug which excites one organ to greater activity may depress another, but the fact that it has any effect whatever on these organs in preference to the tissues in general indicates some special bond between them, some quality which is not shared by the unaffected parts of the body. I have, therefore, not differentiated between excitation and depression in discussing this relation. One is tempted to utilize the nomenclature introduced by Ehrlich here and to state that the common reaction is due to the presence of haptophore groups while the nature of the reaction (excitation or depression) depends on the character of the toxophore groups. But while these terms may be convenient when applied to poisons whose chemical composition is altogether unknown, they merely lead to confusion when the question concerns substances of ascertained structure. Thus, as Dale has pointed out, it is impossible to suppose that such substances as tetramethyl-ammonium and tetraethyl-ammonium owe the difference in reactions to specific haptophore groups in the one which are absent in the other. It seems more probable that in this instance and in others the difference in the effect of these bodies in the tissues arises from differences in the behavior of the molecule as a whole than in differences in the affinities of its special parts; that is, that the action of these poisons is due to their physical properties rather than to their chemical structure, although this, of course, is the final determining cause.

In the same way the common reaction of tissues, which I have so far ascribed to their possessing some substance in common, may arise from community of physical relationship, and I wish to avoid the implication borne by the word "substance," which I have used in the widest sense, such as is justified perhaps only by its historical employment in theological or philosophical controversy. The reaction of living tissue to chemical agents may arise from a specific arrangement in its molecule, but may equally be attributed to the arrangement of the molecules themselves. And the curious relationships in the reactions of different tissues may indicate, not any common chemical factor, but a common arrangement of the aggregate molecules. We are far from being able to decide with even a show of probability which of these alternatives is the correct one, and my object today has been to draw attention to these relationships rather than to attempt their elucidation. Hitherto the speculative pharmacologist has been much engaged in comparing the chemical relationship of the drugs which he applies to living tissues; much useful knowledge has been incidentally acquired, and the law has been formulated that pharmacological action depends directly on, and can be deduced from chemical structure. This view, first elaborated in this country, has in recent years shared the fate of other English products in being advertised from the housetops and practically claimed as the discovery of more vociferous investigators. On examining the evidence, old and new, one can not help feeling that attention has been too much directed to those instances which conform to the creed, while the far more numerous cases have been ignored in which this so-called rule fails. The difficulties are very

great; for example, what chemical considerations can be adduced to explain why the central nervous tissues react differently to bromide and chloride, while to the other tissues these are almost equally indifferent; or how can the known chemical differences between potassium and sodium be brought into relation with the fact that they differ in their effects in almost every form of living tissue?

Less attention has been paid to the other factor in the reaction, the properties of the living tissue which lead one cell to react to a poison, while another fails to do so. I have pointed out some curious relations between different organs, but much needs to be done before any general view can be obtained. Further detailed examination of the exact point at which poisons act, and much greater knowledge of the physical characters of the drugs themselves and of the relation of colloid substances to these characters, are needed. We must attempt to classify living tissues in groups not determined by their morphological or even functional characters, but by their ability to react to chemical agents. Advance is slow, but it is continuous, and if no general attack on the problem is possible as yet, our pickets are at any rate beginning to give us information as to the position of the different groups to be attacked. And when a sufficient number of these qualitative reactions have been ascertained for any form of living matter, it may be possible for some Darwin to build a bridge from the structural chemistry of the protein molecule to the reactions of the living cell. We can only shape the bricks and mix the mortar for him. And my purpose to-day has been to indicate how the study of the effects of drugs on the living tissue may also contribute its mite towards the great end.

A. R. Cushney

FIELD MEETINGS OF THE ASSOCIATION OF AMERICAN STATE GEOLOGISTS

The state geologists of Connecticut, Florida, Illinois, New Jersey, New York, North Carolina, Ohio, Oklahoma, West Virginia and Wisconsin, the director and chief geologist of the Federal Survey, together with the staff of the New York Geological Survey and a few invited guests were in attendance on some or all of the field meetings of the Association of American State Geologists on September 4 to 9. The meetings were held in New York state by invitation of the director of the New York Geological Survey, Dr. John M. Clarke.

September 4–5. The field meetings began September 5 after a preliminary meeting on the previous evening in the office of the director in the State Museum at Albany. The first excursion was by autobus to the Indian Ladder of the Helderberg escarpment, where the classic Helderberg section is well developed. The more refined subdivisions were pointed out by Dr. J. M. Clarke, Dr. R. Ruedemann and Dr. E. O. Ulrich, and the reasons for the subdivisions and for some recent changes in nomenclature were discussed. Contacts between the Indian Ladder beds (Hudson River) and Brayman shales, and between the Brayman shales and Manlius limestone were studied and the cause of the brecciated character of the beds was considered.

The karst topography developed where the Onondaga limestone reaches the surface was seen as the party motored to Thompson's Lake. This lake is believed to rest in a solution basin from which the water drains through underground passages.

At Altamont the party was most agreeably entertained at tea by Mrs. John Boyd Thacher, donor to the state of New York of the Helderberg escarpment, of which the Indian Ladder is the most picturesque portion and which is known as the John Boyd Thacher Park. In the evening the party assembled in the office of the director of the New York Survey for a conference.

September 6. Wednesday morning the party went by train to Saratoga Springs, where it

was met by the superintendent, Mr. Jones, the engineer, Mr. Anthony, and Dr. Ferris, of the Mineral Springs Reservation, under whose guidance the various springs and the fault along which they occur were seen. The structural features of the region and the relation of the fault to the underground water was pointed out by members of the New York Geological Survey. The party then proceeded to the remarkable Cryptozoan ledge (property of the State Museum) which is a glaciated algal reef consisting of several beds of cabbage-like, calcareous algæ in the Hoyt limestone (Upper Cambrian).

A delightful luncheon was tendered the geologists by Mrs. J. Townsend Lansing at Saratoga. In the afternoon a visit was made to historic Crown Point on Lake Champlain with its ruins of Fort St. Frederic (1731) and Fort Amherst (1759), the latter being one of the most important colonial fortifications, said to have cost 2,000,000 pounds. On the parade grounds and in near-by exposures Ordovician rocks with their contained fossils were studied.

September 7. Thursday morning was spent at Mineville where, through the courtesy of the Witherbee, Sherman Co., the members of the party were given an opportunity to visit some of the underground workings of the great magnetite deposits. The magnetite bodies occur in lenses, sheets and pods, surrounded by light-colored gneiss and syenite, and yield both concentrating and high-grade ores, with low and high phosphorus content. The output of the mines is more than 1,000,000 tons a year, not including apatite, which as a by-product is manufactured for fertilizer.

In the afternoon exposures of the Precambrian showing faulting, folding and other complexities of structure were seen under the direction of Assistant State Geologist D. H. Newland. The complex relations of the various gneisses and schists, Grenville limestones, syenite, gabbro and trap dikes were studied in most extraordinary exposures along the Delaware and Hudson railroad track.

At an informal meeting Friday evening at Port Kent, among other questions of general interest, the following topics were discussed: the advisability of encouraging technical schools to require a more adequate training in geology for civil engineers; the necessity of bringing to the attention of the officers of the regular army and militia the importance of a thorough understanding of topographic maps as an essential preparation for military maneuvers; the desirability of offering to the government the services of the state surveys in preparations for national defense.

September 8. The party left Port Kent, where the night had been spent, for the picturesque Ausable Chasm, a post-glacial gorge in Potsdam sandstone, whose course has been determined in large measure by faulting and jointing.

By invitation of the Rt. Rev. Mgr. John P. Chidwick, president of the Catholic Summer School at Cliff Haven on Lake Champlain, the geologists were guests of the school for luncheon at the Champlain Club.

An interesting fourchite dike near the summer school and fine exposures of the Chazy and Beekmantown limestones occupied the time of the party until it was taken by Professor G. H. Hudson to Valcour Island. Under his guidance it was made possible to see the results of his investigations of the fault problems of the island. Interformational breccias, storm tossed reef masses, and tornado records are also among the interesting geological features shown. Professor and Mrs. Hudson gave a camp supper to the members of the party, a feature which added a particularly enjoyable evening to a day full of pleasure and profit. At its close the party went to Plattsburg, where the night was spent aboard the steamer *Vermont*, preparatory to the trip to Burlington in the morning.

September 9. At Burlington, Vermont, the party broke up, some returning home and some remaining with Professor G. H. Perkins, under whose guidance they saw the great overthrust fault on the shore of Lake Champlain near Burlington, in which light-colored Cambrian sandstones overlie black Utica shales; the buildings and museum of the University of Vermont; and finally the great

marble quarries at West Rutland, to which they were taken in automobiles furnished through the courtesy of the Vermont Marble Company.

The great success of these field meetings was due not only to the region traversed, which is unusually interesting geologically and historically, but also to the care with which every detail was planned and executed, and the pains which the director of the New York State Geological Survey and his staff took to provide for the comfort and pleasure of the party.

This report was written at the request of the busy secretary of the association, Dr. W. O. Hotchkiss, by the undersigned guest of the association.

Herdman F. Cleland
Williamstown, Mass.

THE NEWCASTLE MEETING OF THE BRITISH ASSOCIATION

We learn from the account of the meeting in *Nature*, that the attendance was 626, the smallest since the first meeting held in York in 1831. It is said, however, that the attendance at the meetings of the sections was quite up to the average.

The general committee adopted a recommendation of the council that research committees should have power to report through organizing committees of sections to the council at any time when the association is not in annual session. Hitherto research committees have had to await the annual meeting before presenting their reports, even when their conclusions call for early action. Under the new rules this will no longer be necessary if the organizing committee to which a research committee presents its report considers it desirable to report direct to the council. Another alteration of the rules of the association makes it possible for the council to include upon research committees persons who are not members of the association, but "whose assistance may be regarded as of special importance to the research undertaken."

The general treasurer has reported to the council that Mr. M. Deshumbert proposed to leave a legacy of about £5,000 to the association, subject to the condition that his wife and her sister should receive the interest during their lifetime.

The new members of council elected by the general committtee are Mr. R. A. Gregory, Dr. S. F. Harmer, Dr. E. J. Russell, Dr. A. Strahan and Professor W. R. Scott. An invitation to meet in Cardiff in 1918 was unanimously and gratefully accepted by the committee.

The total grants of money appropriated by the general committee for purposes of research committees proposed by the various sections amounted to £602. The subjects and grants are as follows:

Section A.—Seismological observations, £100; annual tables of constants, £40; mathematical tables, £20; gravity at sea, £10.

Section B.—Dynamic isomerism, £15; Eucalypts, £30; absorption spectra, etc., of organic compounds, £10.

Section C.—Red Sandstone rocks of Kiltorcan, £4; Paleozoic rocks, £20.

Section D.—Biology of the Abrolhos Islands, £6; inheritance in silkworms, £20.

Section F.—Fatigue from an economic point of view, £40; replacement of men by women in industry, £20; effects of war on credit, etc., £10.

Section G.—Stress distributions, £40.

Section H.—Artificial islands in the lochs of the Highlands of Scotland, £5; physical characters of ancient Egyptians, £2, 12s. (unexpended balance); Paleolithic site in Jersey, £30; excavations in Malta, £20; distribution of Bronze age implements, £1, 14s. (unexpended balance).

Section I.—Ductless glands, £15; psychological war research, £10.

Section K.—Physiology of heredity, £45; ecology of fungi, £8.

Section L.—School books and eyesight, £5; work of museums in education and research, £15; effects of "free-place" system upon education, £15; science teaching in secondary schools, £10; mental and physical factors involved in education, £10.

Corresponding Societies' Committee.—For preparation of report, £25.

SCIENTIFIC NOTES AND NEWS

Sir Charles Parsons, the engineer, has been elected president of the British Association for the meeting to be held at Bournemouth in September next.

THE executive committee of the Pacific Division of the American Association for the Advancement of Science has elected Dr. John Casper Branner, president emeritus of Stanford University, as president of the division for the year 1916–17. The executive committee includes in addition to the president of the division, the vice-president, Dr. D. T. MacDougal, director of the department of botanical research, Carnegie Institution of Washington, Tucson, Arizona, who is chairman of the committee, and the following elected members: E. C. Franklin, professor of chemistry, Stanford University; T. C. Frye, professor of botany, University of Washington, Seattle; C. E. Grunsky, consulting engineer and former member of the Panama Canal Commission, San Francisco; G. E. Hale, director of the Mount Wilson Solar Observatory, Carnegie Institution of Washington, Pasadena; V. L. Kellogg, professor of entomology, Stanford University, now with the commission for relief in Belgium, Brussels; A. C. Lawson, professor of mineralogy and geology, University of California; and E. P. Lewis, professor of physics, University of California.

THE American Chemical Society will hold an adjourned meeting in affiliation with the American Association for the Advancement of Science in New York City during convocation week. The society originally planned to meet with the association at that time, but finally decided that it was best to meet simultaneously with the National Exposition of Chemical Industries, which it was necessary to hold in September. The next annual meeting of the society will be held in Boston in September, 1917. Dr. E. G. Love, of New York City, has been elected treasurer of the society, to succeed Dr. A. B. Hallock, who has acted as treasurer for the past twenty-five years. Dr. Charles H. Herty, head of the department of chemistry in the University of North Carolina and the present president of the American Chemical Society, has been elected editor and manager of the *Journal of Industrial and Engineering Chemistry*. Dr. Herty will take up this work in New York City on January 1. The journal has hitherto been edited by Professor M. C. Whittaker, in charge of industrial chemistry at Columbia University, who is unable to give his entire time to the work.

WE learn from *Nature* that the fourth annual meeting of the Indian Science Congress will be held at Bangalore on January 10–13, with Sir Alfred Bourne as president. The following sectional presidents have been appointed: Mr. J. MacKenna (Pusa), agriculture and applied chemistry; the Rev. D. Mackichan (Bombay), physics; Dr. Zia Uddin Ahmad (Aligarh), mathematics; Dr. J. L. Simonsen (Madras), chemistry; Mr. K. Ramunni Menon (Madras), zoology; Mr. C. S. Middlemiss (Calcutta), geology.

PROFESSOR J. G. SANDERS, the newly appointed Pennsylvania State Economic Zoologist, has begun his work. He has been visiting the agricultural region with Governor Brumbaugh and has taken up the reorganization of his division.

DR. WILLIAM H. DAVIS, of Boston, has been appointed chief statistician, division of vital statistics, United States Bureau of the Census. Dr. Davis has been the vital statistician of the Boston Health Department for some years, and was appointed to his present office on the basis of a civil service examination.

DR. SIDNEY D. JONES has been placed in charge of the Fort Dodge (Iowa) Clinical and Roentgen-Ray Laboratory, succeeding Dr. Thomas H. Glenn.

DR. WALTER DILL SCOTT, professor of psychology at Northwestern University, is on leave of absence for the current year acting as director of the Bureau of Salesmanship Research in the Carnegie Institute of Technology, Pittsburgh, Pa.

PROFESSOR GEORGE H. WHIPPLE, professor of sanitary engineering at the Massachusetts Institute of Technology and secretary of the School for Health Officers, has been retained by the New York State Board of Health as scientific adviser in the matter of the garbage nuisance on Staten Island. Here the plant of a private contractor was licensed and

erected despite the protests of the citizens, and on an appeal to the state an investigation was set on foot. Professor Whipple is associated with Theodore H. Horton, chief engineer of the state department.

Nature reports that the king in council has appointed Mr. Arthur Henderson, M.P., a member of the committee of the privy council for the organization and development of scientific and industrial research. The other non-official members of the committee are Lord Haldane, the Right Hon. A. H. D. Acland, and the Right Hon. J. A. Pease, M.P. Mr. Henderson was the president of the board of education when the government's research scheme was published in July of last year. As such he was a member of the committee, which includes also, as official members, the lord president of the privy council, the chancellor of the exchequer, the secretary for Scotland, the president of the board of trade, and the chief secretary for Ireland.

Professor C. T. Brues, of the Bussey Institution, Harvard University, has been investigating the possible rôle of insects in the transmission of infantile paralysis during the epidemic of this disease in New York City. These studies are being carried on under the auspices of the New York city board of health.

General W. C. Gorgas, U. S. A., chairman of the Yellow Fever Commission of the Rockefeller Foundation, with other members of the commission arrived in New York last week, from San Juan. The commission visited Chile, Bolivia, Peru, Ecuador and Panama and was obliged to return to New York to take a steamship for Para, Rio de Janeiro and Santos. Besides General Gorgas, who got four months' leave of absence from the army to aid the investigation, the commission includes Dr. Henry R. Carter, United States Public Health Service, clinician; Dr. Juan Guiteras, head of Public Health Service of Cuba, clinician and general adviser; Dr. C. C. Lyster, clinician; Dr. Eugene R. Whitmore, pathologist, and Dr. William D. Wrightson, sanitation engineer.

Sir Ernest Shackleton is said to be now hastening the settlement of matters in connection with the Weddell Sea party of his expedition so as to get over to Australia at the earliest possible moment. Through the generosity of the commonwealth and New Zealand governments the *Aurora* is being repaired and refitted to go south to rescue the ten men of Lieutenant Mackintosh's party marooned at the Ross Sea base.

Dr. J. N. Rose, of the Carnegie Institution of Washington, left on October 4 for another trip to the deserts of South America. This time he will visit the coasts of Venezuela, where many new species of cactuses have been collected and described.

Dr. Christen Lundsgaard left Copenhagen on September 21 for New York. He is the first Danish physician to receive an allowance from the Niels Poulsen American-Scandinavian Foundation. He will study at the Rockefeller Institute and later will travel and pursue research work at other institutions in the United States.

At Harvard University an "Infantile Paralysis Commission" for the treatment and study of infantile paralysis has been appointed consisting of Robert Williamson Lovett, A.B., M.D., chairman, professor of orthopedic surgery; Milton Joseph Rosenau, M.D., A.M., professor of preventive medicine and hygiene; Francis Weld Peabody, A.B., M.D., assistant professor of medicine, and Roger Pierce, A.B., secretary.

The annual autumn meeting of the British Institute of Metals was held on September 20, in the rooms of the Chemical Society, London, Sir George T. Beilby presiding.

A memorial research laboratory is proposed to the memory of Dr. Earl C. Peck, first assistant resident physician at the Philadelphia Hospital for Contagious Diseases, who died recently from anterior poliomyelitis.

A biography of the late Professor James Geikie, of Edinburgh University, is in course of preparation, and it would be a great favor if those who have letters or communications of general interest from him would forward

these to Dr. Marion Newbigin, Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh. They would be carefully preserved, and returned after being copied. Correspondence is also invited from American men of science and others who came into contact with Professor Geikie in the course of his visits to the states.

DR. C. T. CLOUGH, for forty years a member of the British Geological Survey, died on August 27, having been run over by a train while examining rock explosives in Scotland.

PROFESSOR H. MOHN, the meteorologist, of Christiania, died on September 12, at eighty years of age.

ERIC WARR SIMMONS, a recent graduate of University College, London, a geologist of promise, has been killed in the war.

DR. FERDINAND FISCHER, professor of chemical technology in the University of Göttingen, has died at the age of seventy-four years.

HENRI FISCHER, the French student of malacology, has died at the age of fifty years.

THE death is announced at the age of sixty-one years of Dr. Francesco Bassani, professor of geology in the University of Naples.

THE Hospital for Deformities and Joint Diseases, New York, has received from Mr. Herbert Kauffman, of Pittsburgh, through Dr. H. D. Frauenthal, a gift of one million dollars, to be used for the erection of a new building and as an endowment fund.

BEFORE the Tax Budget Committee of the New York City Board of Estimate it was reported that the attendance at the Metropolitan Museum of Art for the year ending June 30, 1916, was 635,206, as against 778,024 for the previous year. The paid admissions for 1916 were 31,617, as against 40,311. The committee voted $200,000, the same amount as last year, although the request was for $250,000. On the other hand, the American Museum of Natural History showed an increase in attendance, and Cleveland H. Dodge, appearing for the trustees, said this was due to school teachers taking their classes to the museum. The attendance for the year ended June 30 was 870,000, as against 664,215 for 1915. Last year the museum received $212,999, and this year requested $222,000, but only $212,700 was recommended.

THE following resolution was unanimously passed at the Dyestuff Conference held during the meeting of the American Chemical Society on Tuesday afternoon in Rumford Hall, the hall being crowded to its utmost capacity.

WHEREAS, the revenue bill (title, V. Dyestuffs) which recently passed the Senate after hearings of representatives of producers and consumers, accorded to *all* classes of dyestuffs without exception an ad valorem duty of 30 per cent. and a specific duty of five cents per pound, and

WHEREAS, in the final conference between the House Ways and Means Committee, and the Finance Committee of the Senate, and without further hearings, "Natural and Synthetic Alizarin and Dyes Obtained from Alizarin, Anthracene and Carbazol, Natural and Synthetic Indigo and All Indigoides whether or not obtained from Indigo, and Medicinals and Flavors" were made exceptions and to carry no specific duty and to have only the 30 per cent. ad valorem duty. The Dyestuff Conference of the American Chemical Society, in a meeting held in New York, September 27, without a single dissenting vote, condemns the exception of these dyestuffs from this specific duty, as this exception undermines the very foundation upon which it was hoped that the American dyestuff industry might be built. It makes it impossible for the American manufacturer to meet the requirements of this Bill "if, at the expiration of five years from the date of the passage of the Act, the President finds that there is not being manufactured or produced within the United States as much as 60 per cent. in value of the domestic consumption of these articles, he shall by proclamation so declare, whereupon the special duty imposed by the Section on such articles shall no longer be assessed, levied, or collected."

AND WHEREAS the value of these excepted classes of dyes amounts to approximately 30 per cent. of the dyes consumed in the U. S. A., without considering the dyes patented by foreign manufacturers,

Therefore be it resolved, that we condemn the removal of these dyestuffs from the special tariff accorded to them by the Senate as detrimental to the establishment and development of the Ameri-

can dyestuff industry and subversive of the best interests of the American people.

UNIVERSITY AND EDUCATIONAL NEWS

At the September meeting of the Yale Corporation the treasurer reported further distribution of about $685,000 from the estate of the late Justus S. Hotchkiss of New Haven. Other gifts include approximately $10,000 additional for the Hepsa Ely Silliman Lectureship Fund, from the estate of the late Augustus E. Silliman; $15,000 for the Charles W. Goodyear Memorial Scholarship Fund in the School of Forestry; and $5,000 more from Mrs. Helen Newberry Joy and Messrs. John S. and Truman Newberry for the work of rebuilding and enlarging the Newberry organ in Woolsey Hall.

The *Journal* of the American Medical Association announces that one of the final transactions of the merger of the medical school of the University of Pennsylvania, the Medico-Chirurgical College, and Jefferson Medical College was consummated, September 21, when the real estate holdings of the Medico-Chirurgical College were transferred to the trustees of the university. The college buildings, assessed at $375,550, and two four-story houses, assessed at a total of $54,000, were conveyed for a nominal consideration. These will eventually be conveyed to the city by the university and the buildings demolished, as they are in the line of the new parkway.

The department of botany of the Massachusetts Agricultural College and Experiment Station has been reorganized with the following personnel: A. Vincent Osmun, professor and head of the department; George H. Chapman, research physiologist; P. J. Anderson, associate professor and associate pathologist; Orton L. Clark, assistant professor and assistant physiologist; F. A. McLaughlin, instructor; G. W. Martin, instructor.

Tufts Medical School announces several changes in the faculty. Andrew H. Ryan, M.D. (Washington University), will take charge of the department of physiology. Charles H. Baily, M.D. (Harvard), has been made associate professor of histology. R. Harmon Ashley, Ph.D. (Yale), will take charge of the department of chemistry in the dental and pre-medical school. Arthur L. Chute, M.D., has been advanced from assistant professor to associate professor of surgery, and Gilmore C. Dickey, D.M.D., from instructor to assistant professor of crown and bridge work.

Northwestern University has appointed the following instructors: In the department of mathematics: Rutherford Erwin Gleason, B.A., Charles Edwin Wilder, Ph.D., Frank Edwin Wood, B.A., and Irwin Romans, M.A.; in the department of chemistry: Martin William Lisse, M.S. (University of Washington), and Wallace Jennings Murray, Sc.D. (Geneva, Switzerland), instructors in chemistry; Louis Wade Currier, B.S. (Mass. Tech.), instructor in mining and metallurgy. The following promotions have also been made: George Vest McCauley, Ph.D. (Wisconsin), becomes assistant professor of physics, and Chester Henry Yeaton, Ph.D. (Chicago), assistant professor of mathematics. Henry Andrews Babcock, Ph.D. (Northwestern), has been appointed an instructor in physics.

Frederick Lyons Brown, of Northwestern University, has been appointed instructor in astronomy for the Dearborn Observatory.

Dr. S. Morgulis, of the department of physiological chemistry, college of physicians and surgeons, Columbia University, has been appointed professor of physiology in the Creighton University Medical College, Omaha, Nebraska.

Under the general direction of Mr. A. G. Perkin, who is a son of Sir W. H. Perkin and brother of Professor Perkin, of Oxford, a new staff has been appointed to the dyeing department of the University of Leeds. Some of the members will give special attention to the exclusive requirements of British Dyes (Limited), but most of them will devote their services to work which may best meet the needs of other firms. In addition to the scien-

tific investigation of anilines, the working out of processes, and the study of the constitution of color, particular regard is to be paid to coal tar distillation and the industrial application of cellulose. Another feature will be an experimental dyehouse. Mr. G. H. Frank, M.Sc., and Dr. Oesch, a Swiss expert, are retained on the staff, and with them will be associated Mr. P. E. King, Lieutenant A. E. Woodhead, M.Sc., Professor E. R. Watson, D.Sc., of Dacca College, and, as outside lecturers, Mr. H. P. Hird and Mr. C. F. Cross, both specialists engaged in allied industries.

DISCUSSION AND CORRESPONDENCE

ATMOSPHERIC TRANSMISSION

TO THE EDITOR OF SCIENCE: On page 168 of your issue of August 4, 1916, Mr. Very is unfair to himself, to your readers, and to me. He points out that the Smithsonian Mount Wilson observations of September 20 and September 21, 1914, indicate greater transparency of the atmosphere for the complete, complex solar beam made up of energy of all wave-lengths the greater the air mass. From this he tries to lead your readers into the conclusion that the atmosphere gradually decreased in clearness during our period of observations. Nobody knows better than Mr. Very of Langley's mathematical proof that a complex beam traversing a medium the transmissive power of which varies with the wave-length must necessarily behave in this manner even though the medium is perfectly homogeneous. Pure water or glass would show the same effect. The transmission would continually increase for each successive layer traversed. This is because the less transmissible rays are continually becoming a smaller proportion of the intensity of the whole complex beam the farther it goes through the medium. If our pyrheliometric observations *had not shown* the phenomenon which Mr. Very mentions they would have proved that the sky was growing clearer. The question then only remains whether the effect they do show is of the right magnitude or not. This is settled affirmatively by the results obtained with the spectro-bolometer.

For monochromatic rays the atmospheric transmission should be constant for all air masses, if the atmosphere neither grows clearer nor more opaque. Our spectro-bolometric work shows that this condition was closely fulfilled on the two days in question, as Mr. Very well knows. Having no comfort from the spectro-bolometric work, he omits mention of it, and tries to carry his point with the uninformed by paradoxing.

Mr. Very, however, draws attention to the increase of atmospheric humidity during the observations as indicated by Fowle's measurements. It may be remarked that between air-masses 11.0 and 7.2 on September 20 no appreciable change occurred. Yet that part of the observations gives the same result as the rest, showing that the effect of such small increase of humidity as occurred during the rest of the morning was negligible. Those who consult the original derivation of Fowle's method of estimating atmospheric humidity, are, however, aware that it rests on laboratory experiments extending only to 5 millimeters of precipitable water. For the exceptionally large air masses occurring on September 20 and 21 it was applied to the estimation of over 65 millimeters. It seems as likely that this extreme extrapolation involved inaccuracy, increasing with increasing air-mass rather than that the atmospheric humidity really increased from 3.3 to 4.0 millimeters during so short a time as the first 8 minutes after sunrise. I therefore incline to think that there was very little or no increase at all in atmospheric humidity on September 20 between air masses 19 and 3, although a small increase from 3.3 to 5.2 is indicated by Fowle's results. Later on there was really a small increase of humidity, but it appears to have been insufficient to produce appreciable error in the solar-constant values as calculated from small air masses.

As to the clearness of the sky at Flagstaff, Arizona, in August, 1912, Mr. Very shows that it was clearer there, at 7,000 feet elevation, than he is accustomed to find it near Boston, but he does not show that it was clear sky at Flagstaff. If it was really exceptionally

clear there at that time, it adds one more to the long list of wonders associated with that observatory.

In regard to the third matter, relating to the transmission of terrestrial radiation, I am quite unable to understand Mr. Very's logic. His mind seems to let through the consideration of rays that rise vertically from the earth's surface, but to abolish all thought of those which rise obliquely. Like every other surface, all parts of the earth's surface emit rays in all directions within a hemisphere, and tend to cool by the loss of the energy of all these rays which they emit. The loss is to some extent compensated by rays which reach the earth from every one of these directions, and which at night come mainly from the emission of the atmosphere itself. Mr. Ångström and others have measured at night the excess of the radiation emitted by a horizontal blackened surface, at terrestrial temperature, over the radiation received by such a surface from above. There is no great disagreement in the observation. All observers find the net loss of radiation at 20° C. to be from 0.12 to 0.20 calories per sq. cm. per minute, depending on the state of the atmosphere. But Mr. Very maintains that the whole of this loss represents energy that is transmitted entirely through the atmosphere in direct beams from the earth's surface to space. I see no reason to admit this at all. What is measured is a difference between the energy of two beams of rays, one leaving the surface, the other reaching it. If the atmosphere (taking its entire thickness) was totally opaque to these rays, there would still be a difference in these amounts of energy, because the atmospheric sources are at a lower temperature than the earth's surface.

To determine the transmission of the earth's surface-radiation through the atmosphere, as I define it, one must sum up the total of all radiant energy which, having been emitted by a horizontal fragment of the earth's surface, escapes outside the atmosphere into space, by whatever path, without having suffered true absorption and re-radiation. The sum total just described divided by the original quantity emitted by the same element of surface is the transmission. Perhaps Mr. Very has in mind the coefficient of vertical transmission. This is naturally larger than mine, but it does not serve to indicate the rate of loss of heat of the earth's surface by radiation. That depends on the rate of loss by oblique rays as well as that by normal ones.

C. G. Abbot

Mount Wilson, Calif.,
August 17, 1916

A REMARKABLE AURORAL DISPLAY

Between eight and nine o'clock on the evening of August 26 I stepped out on the porch of our cottage on the shore of Lake Douglass in northern Michigan and noticed what I at first mistook for an unusually bright twilight for that date and hour.

Looking up through the tree-tops I saw a curious flickering as of sheet lightning on a bit of cloud. But there was a peculiar streaming movement which at once suggested an auroral phenomenon, although I was looking towards the south! Passing around the house to an open field, I was fairly staggered with such a spectacle of light in motion as had never been dreamed of by any of our family group of eight which at once answered my cry of amazement.

Practically the whole vault of the heavens was alive with light. Light in patches, bands and arches; in streamers, sheets and delicate pencillings. Clear from the northern horizon to the zenith, and far beyond until the southern sky was invaded to within about four degrees of the horizon, and was utilized for the unfolding of the display.

I had seen what I thought to be fine auroras much farther to the north, but had never even heard of one which required almost the entire expanse of the heavens for its staging.

The focus of the spectacle was the zenith itself, and around this was a shifting and irregular zone of light below which almost the entire sky was set with masses of shifting, shimmering radiance constantly changing shape as if the sky were a vast kaleidoscope. It seemed, indeed, as if we stood beneath the

center of the dome of the firmament, whose vault was composed of bands and changing masses of streaming light, the quivering waves of which were surging upward toward the disk of blue at its apex. A brighter arch spanned the northern horizon, and this also was undergoing constant transformation.

It was not the light itself, marvellous as were its mass, zones, banners and steamers, that most thrilled the observers. Such a vast display of light in constant *movement* had never before been seen nor imagined by any of us. The whole heavens shuddered and staggered, shivered into a swirling chaos and reformed again and again in new and still more weird aggregates of shimmering light. Light streamed and wavered, rippled, flickered and pulsated. Now it was in broad waves reaching to the zenith, and now in vibrating bands. Here a broad cone shot up from the northern horizon until its apex pierced the very mid-heavens, and in the twinkling of an eye it was gone. There, from the shifting zones around the zenith, ripples of light passed upward to the blue apical disk. To the naturalist no more apt figure of this rippling motion could be suggested than the waves of light passing along the meridional bands of phosphorescent Ctenophora.

Again, a delicate fringe of pencil points would appear on the upper edge of one or more of the shifting zones and then shoot upward with inconceivable rapidity in sharp vibrating pencillings of light. As mentioned before, the focus of all these movements was the zenith itself, which seemed to be undergoing an intense bombardment of waves, ripples and searchlights from all sides, although subsidiary lateral movements were also in evidence.

Marvellous as was the rapidity of movement, the rapidity of change or kaleidoscopic effect was no less astonishing. Over and over again one of the observers would try to call attention to some particularly vivid display, only to find it utterly gone before the others could turn their eyes in the direction indicated. These changes were much more rapid than in other auroras seen by the writer. Nothing but electrical phenomena could approach their instantaneous shiftings.

At first the light was all pure white radiance, exactly that of electricity. Later certain areas took on a rose color, and still later the display more closely resembled that of ordinary auroras, being concentrated in the broad arch across the northern sky and showing more variety in colors.

So absorbed were the observers in this grand spectacle of light in motion that it was long before they noted the peculiar effect of the light upon themselves and their immediate surroundings. Then we saw that it was a perfectly diffused light, coming in practically equal intensity from all points of the sky. A more *unreal* scene could hardly be imagined. It was unlike moonlight, for there were no shadows nor shadings. On that account all objects seemed much less brilliantly illuminated than they really were. It was most like the light of early dawn; but still different, for in the dawn the light, although diffused, is all from one side. Objects were distinctly visible, but flat. Our companions' faces could be seen quite plainly, but lacked individuality. The opposite shore of the lake could be seen much more distinctly than in bright moonlight and objects inside the house were quite distinct, even if small.

How long the display lasted we do not know, although one of the party reported it as striking as ever well past midnight. Finally the chill of the night and the aching of our strained necks drove us indoors with the conviction that never again should we see such a stupendous spectacle of light in motion.

C. C. NUTTING
STATE UNIVERSITY OF IOWA

INCREASING DEPTH OF FOCUS WITH THE SWING-BACK

TO THE EDITOR OF SCIENCE: The writer admits his membership in the not inconsiderable class of field workers who are never satisfied with their photographic results. A little discovery, however, recently enabled him to improve the focus on certain classes of deep-focus pictures and he excuses the description

of a method of procedure which may be well known to photographers by the fact that it appears to be unknown to nearly all of the working geologists and zoologists with whom it has been discussed.

The utilization of the swing-back to eliminate distortion in the photographs of high buildings has long been known; the subject of this note is the application of the same method to increasing the depth of focus where both foreground and distance are desired, the swing-back being so manipulated as to increase the distance between the lens and the foreground portion of the photographic surface and to lessen the distance to the background portion of the same. The method is of course inapplicable where the objects in the foreground are high, and the element of distortion might bar it for some pictures, but useful applications of the method are many and will occur to all.

Lancaster D. Burling
Ottawa, Canada

SCIENTIFIC BOOKS

Grundlagen und Methoden der Paleogeographie. Fundamental Problems and Methods of Paleogeography. By Dr. Edgar Dacqué, Privatdozent an der Universität München. Gustav Fischer, Jena, 1915.

Dacqué's notable work is a comprehensive review of the literature of paleogeography and of the opinions of many geologists, representing German, Austrian, French, English, American, Swedish, Norwegian, Dutch and Italian thought, regarding the problems of the science. The list of authors cited comprises nearly five hundred names. The citations are so arranged that the views of any thinker on a specific problem are stated in appropriate context with those of others who may or may not agree with him. For the most part they are abstracts or interpretations, but Dacqué's presentation is accurate and impartial to a degree which may even seem lacking in discrimination, since speculations and respectable theories are treated with similar consideration. There is, however, a certain justification for this attitude, paleontology being in a very speculative stage of development and its problems being open to various tentative solutions. The work having been prepared for courses of lectures given at the University of Munich in 1912–13 and 1913–14 is marked by a didactic character. The advanced student will therefore find in this comprehensive review much that may seem elementary; he will also find much that is suggestive and helpful.

The chief value of the work for American readers lies in the numerous references to foreign writers and to views which are given more serious consideration by European geologists than they commonly are among Americans. In so far as American thought has been influenced by Chamberlin's far-reaching and fundamental studies, it has abandoned some theories to which Dacqué gives credit and has advanced to concepts which he does not discuss.

The introduction and the history of the literature of paleogeography for the past thirty-five years occupy the first forty pages of the work, and are followed by a discussion of the surface and structure of the earth. The statement includes the tetrahedral theory, as well as the disruption of the moon from the earth on the site of the Pacific Ocean, and closes with a consideration of the constitution of the earth on the assumption that the spheroid consists of a core of nickel iron separated from the known lithosphere by a zone of molten, yet rigid, magma, which allows horizontal displacements of the crust to occur. There is a certain parallelism with Barrel's hypothesis of an asthenosphere or zone of weakness, but German speculation suggests the possibility of horizontal movements of the outer crust far in excess of any that have been postulated by American investigators. Thus Dacqué discusses, as being within the range of credible hypothesis, wanderings of the pole amounting to twenty-five degrees of latitude and the even greater displacements of the continental masses postulated by Wegener.

Changes in the position of the pole might occur through absolute change in the position of the earth's entire mass with reference to the axis of rotation, or through relative move-

ment of an outer shell over the internal core, the latter retaining a constant orientation. Astronomical considerations are opposed to an absolute change in the position of the pole, at least during the eras of known geologic history, but they do not interfere with the possibility of a relative movement of an outer earth skin, either as a whole or in continental segments, provided there be no effective change in the position of the center of gravity of the spheroid. According to Wegener, whose speculations were published in the *Geologisches Rundschau* and in *Petermanns Mitteilungen* for 1912, the lighter continental masses, floating in denser material of the lithosphere, might move laterally. Postulating the sharp distinction of density and the plastic though resistant character of the substratum, which permits slow movements, there is, says Dacqué, no reason to deny that great horizontal displacements of the continental masses may occur, if only it can be shown that there are forces which, during prolonged geologic eras, have acted continuously in a constant direction. Finding such a force in deep-seated lateral stress due to the effort toward isostatic equilibruim, Dacqué concludes that we must hereafter take account of great relative crustal displacements with reference to the mass of the spheroid, regarding them, if not as facts, at least as sound working hypotheses.

It is not the purpose of the reviewer to discuss these concepts, but it may be observed that they may appear reasonable or extravagant according to one's previous education. We have learned to accept horizontal displacements of tens of miles. Overthrusts of this magnitude are clearly demonstrated. The generally accepted interpretation of Alpine structure has familiarized European geologists with the thought of much greater horizontal movements which are supposed to have resulted in piling slice upon slice of the superficial strata and basement rocks, far in excess of the ability of rocks to transmit crushing strains. Fifteen years ago Lugeon's extraordinary views were regarded as impossible. Now only a very small minority of his colleagues still opposes them, and the general agreement of the masters influences the younger generation of European geologists, schooled to accept an interpretation of mountain structure which contradicts the laws of mechanics and physics.

In a chapter on the rise and sinking of lands or changes of the oceanic level Dacqué reviews current theories of the causes of epeirogenic and orogenic movements, as they are represented in the writings of Suess, Wegener, Termier, Lachmann, Andrée, Haug, Daly, and others. The tendency is toward an abandonment of the contraction theory, the assignment of a minor rôle to isostatic adjustment in epeirogenic changes of level, and a return to the old plutonic or thermal hypothesis in some modified form, especially with reference to the subsidence of geosynclines and the subsequent folding and elevation of the accumulated sediments. Alpine studies again furnish the principal basis of European speculation, but there is also an appeal to English and American thought.

The permanence of oceanic basins is a theme which Dacqué discusses with a full appreciation of its importance in paleogeographic studies and of the diametrically opposite views held by various authorities. After a comprehensive review of marine transgressions and recessions over continental areas, he cites the arguments for and against permanence of the oceanic basins, and arrives at a sharp contradiction of evidence, which he proceeds to solve by adopting Wegener's suggestion of floating continents. It was Suess who designated the lighter rock masses, composed chiefly of silica-alumina rocks, as "Sal" and heavier ones, consisting of silica-magnesia materials, as "Sima." Assuming them to be differentiated, *sal* may be conceived to be a more or less continuous skin floating in *sima,* and it may be capable of disruption accompanied by separation of the parts. *Sima* forms the ocean bottoms and underlies the masses of *sal* which are the continents. The Pacific is a very ancient ocean basin; the Atlantic and Indian depressions are young. According to Wegener the Americas have become separated from Europe and Africa, and Dacqué finds therein the origin of the intervening deep. He says:

> If in the ancient Pacific from long ago, that is from the opening of the Paleozoic on, the denser Sima lay exposed . . . and if that was the site of the permanent abyss, then has the dense material under the Atlantic and Indian oceans been exposed through displacement of the lighter salic continents, as if by the drawing back of a curtain, and the existing coincidence of the limits of density with the outlines of the continents and oceans is explained. The former invasions of the sea, which are shown to have spread over what are now land areas, are passing transgressions; the Pacific and the continents are permanent, aside from the displacements; the Atlantic and Indian oceans are younger deeps, floored with sima which appears at the surface in consequence of the displacements [of the continents]. Thus the problem of permanence is robbed of its contradictions and in essentials is explained.

The speculative section of the work, occupying 200 pages, thus presents some of the greater problems of geology as the introduction to paleography. Another and in the opinion of the reviewer a sounder method is to proceed from the facts of paleogeography toward the solution of those problems.

As a contribution to the science the latter half of Dacqué's work will seem to many the more valuable. In it are assembled the data of sedimentary formations considered as facts appropriate to paleogeographic investigation, estimates of absolute and relative durations of geologic time divisions, and examples of the construction of paleogeographic maps. The facts of stratigraphy and paleontology are admirably summarized, and the assemblage of illustrations constitutes a rich and suggestive reference for students of the subject.

Bailey Willis
Stanford University

Plant Life. By Charles A. Hall, F.R.M.S. The Macmillan Company, 66 Fifth Avenue, New York, N. Y. Cloth. Pp. 380. Eighty text-figures and seventy-four full-page illustrations. Price six dollars ($6.00).

Professor Hall has already written several books presenting various phases of nature-study in a popular way, so that experience in the field, in the laboratory and in the study have combined to make the present volume on "Plant Life" a useful addition to the series. It is addressed, principally, to the amateur botanist and lover of nature, but contains much which should be of interest to teachers of elementary classes.

The treatment follows the general evolutionary order from the lowest plants up to the highest. The excellent descriptions of field characters is an important feature of the work and should enable the beginner to find even the microscopic forms. Interesting bits of information and clever observations afford welcome material to those who wish to brighten their lectures and laboratory work.

The headings of the twelve chapters indicate not only the scope of the book, but also what might be expected in the mode of treatment. The headings are: Asexual Plants; The Development of Sex in Plants and a Study in Evolution; Seaweeds; Fungi and Lichens; Bryophytes—Liverworts and Mosses; Pteridophytes—Ferns, Horsetails and Club Mosses; Phanerogamia, Flowering Plants; Fossil Plants; The Food of Plants and How they Secure It; The Perpetuation of the Race; The Defences of Plants; Ecology; The New Field Botany. There is a general glossarial index.

The illustrations are excellent and most of them are new. In addition to eighty text-figures, there are seventy-four full-page illustrations, twenty-four being from photographs by the author and fifty in color from drawings by C. F. Newall. The binding and typography are in keeping with the high grade of the illustrations.

Charles J. Chamberlain

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The eighth number of volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The Absorption Coefficients of Soft X-rays:* C. D. Miller, Ryerson Physical Laboratory, University of Chicago.

The numerical constants in the relation between the absorption coefficients, the density,

and the wave-lengths have been accurately determined. The results also indicate that the relationship holds for very much softer X-rays than those of ordinary penetrating power.

2. *Further Evidence as to the Relation between Crown Gall and Cancer:* ERWIN F. SMITH, Laboratory of Plant Pathology, United States Department of Agriculture.

There are discussed: Fundamental concepts, human and animal tumors for which no cause has been discovered, earlier discoveries in plants, further discoveries, other resemblances of crown gall to cancer in man and animals, possibility of the existence of carcinomas and of mixed tumors in plants, production of embryonal teratomata, and bearing of these discoveries on the cancer problem.

3. *Locomotion of Sea-Anemones:* G. H. PARKER, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

The pedal portion of a sea-anemone, like its tentacles, must contain a neuromuscular mechanism sufficient for the activity of that part of its body.

4. *The Behavior of Sea-Anemones:* G. H. PARKER, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College.

Sea-anemones are animals whose momentary conditions are dependent upon the combined stimuli of their immediate surroundings rather than forms that are greatly influenced by their past history, and their unity is not of a pronounced type; they are more in the nature of a sum of parts than they are organic units of the type of most of the higher animals.

5. *A Contribution to the Petrography of Japan:* J. P. IDDINGS AND E. W. MORLEY, Brinklow, Maryland, and West Hartford, Connecticut.

Seventeen detailed chemical analyses are given of Japanese lavas.

6. *Is There a Temperature Coefficient for the Duration of Life?* JACQUES LOEB AND J. H. NORTHRUP, Rockefeller Institute for Medical Research, New York.

In three series of experiments on the fruit fly *Drosophila,* it is found that the duration of life in the cases examined has a temperature coefficient of the order of magnitude which is characteristic for life phenomena and chemical reactions in general.

7. *On the Suggested Mutual Repulsion of Fraunhofer Lines:* CHARLES E. ST. JOHN, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The author is unable to find evidence of the mutual repulsion suggested and in so far as mutual influence is a necessary corollary of anomalous dispersion in the sun, evidence of this also is lacking.

8. *An Attempt to detect the Mutual Influence of Neighboring Lines in Electric Furnace Spectra showing Anomalous Dispersion:* ARTHUR S. KING, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Although the material in the investigation is limited by the scarcity of suitable pairs of lines, the lines actually tested have shown no tendency toward a repulsion.

9. *Synthesis of the Base $C_5H_4ON_2$ derived from Methyl-Aminomethyl-3, 4-Dihydroxyphenyl-carbinol:* CHAS. A. ROUILLER, Pharmacological Laboratory, The Johns Hopkins University.

A continuation of some work by Abel with a suggestion as to a relation to work by Curtius.

10. *Extinguished and Resurgent Coral Reefs:* W. M. DAVIS, Department of Geology and Geography, Harvard University.

11. *The Origin of Certain Fiji Atolls:* W. M. DAVIS, Department of Geology and Geography, Harvard University.

The two papers offer a discussion of observations made during the author's Shaler Memorial voyage across the Pacific.

12. *Interferometer Methods based on the Cleavage of a Diffracted Ray:* C. BARUS, Department of Physics, Brown University.

The prismatic method of cleaving the incident beam of white light is available for the superposition of non-reversed spectra, under

conditions where the paths of the component rays may have any length whatever. It is thus an essential extension of the same method as used for reserved spectra, heretofore, and also of the methods in which the paths are essentially small.

13. *On the Inheritance of Certain Glume Characters in the Cross Avena Fatua XA. Sativa Var. Kherson:* Frank M. Surface, Biological Laboratory, Maine Agricultural Experiment Station.

A study of inheritance of certain characters particularly directed toward revealing phenomena of linkage.

14. *A Comparison of the Rates of Regeneration from Old and from New Tissue:* Charles Zeleny, Zoological Laboratory, University of Illinois.

The data as a whole show clearly that there is no essential difference between the rate of regeneration from new cells and from old cells. The rate of regeneration seems therefore to be under central control.

15. *The Effect of Successive Removal upon the Rate of Regeneration:* Charles Zeleny, Zoological Laboratory, University of Illinois.

Apart from the slowing due to age there is no indication of the amount of new material that may be produced by regeneration. The actual limitation comes not from the using up of regenerative energy, but from changes in the non-regenerating part associated with age.

16. *The Geologic Rôle of Phosphorus:* Eliot Blackwelder, Department of Geology, University of Wisconsin.

Phosphorus appears in nature in many forms and in many situations. Its numerous transformations, however, follow an orderly sequence—in a broad way form a cycle—which is here discussed in some detail.

17. *Dominantly Fluviatile Origin under Seasonal Rainfall of the Old Red Sandstone:* Joseph Barrell, Department of Geology, Yale University.

Geologists have differed so widely in their conclusions in regard to the nature of the habitat of the early vertebrate faunas whose remains are found in the formations of the Old Red Sandstone, that the author is led to examine critically the criteria for the interpretation of the facts. He comes to the conclusion that the deposits which make up the Old Red Sandstone, although they undoubtedly contain lacustrine beds and other beds laid down in shifting, shallow and variable bodies of water, are dominantly fluviatile in origin. The Great Valley in California may therefore in the present epoch, both in physiography and in climate, be cited as a striking illustration of the nature of the Old Red Sandstone basins.

18. *The Influence of Silurian-Devonian Climates on the Rise of Air-Breathing Vertebrates:* Joseph Barrell, Department of Geology, Yale University.

The evidence for the hypothesis of the continental origin of fishes has been examined and seems to prevail over that for their marine origin. The author also believes that natural selection, although discredited as a cause determining specific variations, appears nevertheless to be a major factor in evolution.

19. *Density of Radio-Lead from pure Norwegian Cleveite:* T. W. Richards and C. Wadsworth, 3d, Wolcott Gibbs Memorial Laboratory, Harvard University.

The density of this lead is found to be 11.273, distinctly less than the density (11.289) of Australian radio-lead and still less than that (11.337) for ordinary lead, the decrease being almost exactly proportional to the decrease in atomic weight in these samples, so that the atomic volume (18.281) is constant.

20. *National Research Council.*

A preliminary report to the president of the academy by the organizing committee recently printed in full in Science.

Edwin Bidwell Wilson
Mass. Institute of Technology,
Cambridge, Mass.

SPECIAL ARTICLES

IMBIBITIONAL SWELLING OF PLANTS AND COLLOIDAL MIXTURES

The swelling of gelatine in distilled water, alkali and acid has long been used as refer-

ence phenomena in interpreting the water relations of plants especially in growth, and some conclusions founded on the assumption that growing organs, like gelatine, would show a maximum swelling in acidified solutions are shown by our work to be mistaken ones.

During the course of some comprehensive studies on growth now being carried out at the Desert Laboratory it was deemed desirable to follow the entire course of development of shoots of *Opuntia,* and to make chemical analyses at various stages. Growth depends so largely upon the capacity for absorption and retention of water that numerous measurements of the swelling capacity of developing and mature members were made.

The method consisted in cutting clean disks 12 mm. across from the flattened joints of *Opuntia.* Three of these were arranged in the bottom of a Stender dish and a triangle of thin sheet glass arranged to rest its apices on the three disks. The vertical swinging arm of an auxograph[1] was now adjusted to a shallow socket in the center of the glass triangle while the pen was set at zero on the recording sheet. Water or a solution being poured into the dish, the course of the swelling was traced.

That the amount of imbibition depended mainly upon the presence of certain recognizable substances and not upon properties of the disks as masses of living material was demonstrated by the fact that dried disks gave proportionate differences equivalent to those of living material.

The average thickness of disks varied from 4 or 5 mm. in the case of young joints to 18 or 20 mm. in mature ones. The apical parts of joints showed greater capacity for absorption than the basal ones in the proportion of 21 or 22 to 16 or 17 per cent. Comparative tests were finally based on disks taken from apical regions. The capacity for absorbing water was seen to increase up to maturity (about 1 year old) then to decrease as illustrated by the following set of tests with *Opuntia blakeana* made May 17–29, 1916.

Opuntia blakeana	Young	Mature	Old
Swelling (distilled water) ..	24.3%	50%	41.3%

The amount of imbibition does not appear as a continuous function of any one substance or group of substances, the presence and amount of which were estimated. This would harmonize with the results of swelling mixtures of gelatine and agar described below. The phenomena of proportionate swelling of gelatine in water, acids, alkalies and salt solutions have been mistakenly used hitherto in attempts at explanation of the mechanism of growth. It has been demonstrated by repeated tests that the tracts of growing cells studied, as well as maturing or mature tissues, do not swell more in acid than in distilled water or alkali, as will be illustrated by the following results taken at random from numerous records obtained at Tucson.

SWELLING OF DISKS OF OPUNTIA

	Dist. Water	Sodium Hydrate (Hundredth Normal)	Hydrochloric Acid (Hundreth Normal)
Young.....	23.6 %	22.9%	16.4%
Mature.....	40%	52.1%	36.6%

It is conclusively established that both young and old tissues take up more water when neutral or alkaline. Acidity therefore in addition to retarding enzymatic action presumably including respiration would operate to lessen growth by its effects in decreasing imbibition by plant tissues.

It being demonstrated that growing masses of embryonic cells in plants and tracts of mature tissue show their greatest capacity for the imbibition of water not in acidified but in alkaline solutions, it was sought to find what substance or mixture of substances would behave in a similar manner. The first inquiry was made with agar which is composed of pentoses presumably having some qualities identical with those of the mucilages of the plant. Dried cylinders and sheets of this material were first subjected to the tests, being placed under the auxograph after the manner in which disks of living material were treated as described in a

[1] See MacDougal, D. T., "Mechanism and Conditions of Growth," *Mem. N. Y. Bot. Garden,* 6: p. 14, 1916.

previous paragraph. The results compared with the swelling of gelatine were as follows:

	Sodium Hydrate (Hundredth Normal)	Hydrochloric Acid (Hundredth Normal)	Water
Swelling of agar	124%	113%	197%
Swelling of gelatine..	250%	382%	83%

As the plant did not show water relations which might be interpreted as a mechanical resultant of the separate action of gelatine or agar it was next proposed to test the reactions of a mixture in which these substances would be blended, which was done in July, 1916. The first test mass was one consisting of about equal parts of agar and gelatine, though the quantities were not weighed. Both were soaked and melted separately and the gelatine was poured into the hot agar which was kept at a temperature of about 90° C. for a half hour. The mass was then poured on to a glass slab for cooling. Two days later it was stripped off as a fairly clear and transparent sheet slightly clouded, the average thickness of which was 0.2 mm. Strips about 5 × 7 mm. were placed under the apices of sheet glass triangles in glass dishes after the manner in which plant sections had been tested, and auxographs were arranged to record the action of acids, alkalies and distilled water. The first trial made on July 21 gave the following final relative size of the strips as compared with the original: distilled water 850 per cent.; nitric acid (hundredth normal), 725 per cent.; hydrochloric acid (hundredth normal), 750 per cent.; sodium hydrate (hundredth normal), 950 per cent. No record of the temperature of the room was kept. A second test on the following day at temperatures of 61°–65° F. gave the following: distilled water, 675 per cent.; hydrochloric acid, 625 per cent.; nitric acid, 687.5 per cent.; sodium hydrate, 750 per cent. These results were taken to be of such importance that a series of mixtures of agar with 20, 50 and 80, 95 and 99 per cent. of gelatine by dry weight were made up. The mixtures were poured into moulds on glass plates and dried sheets from 0.1 mm. to 0.6 mm. in thickness were obtained. The measurements given below include the results of tests under varied conditions not only of thickness of the samples, but also of temperature, length of period of swelling, tension of instruments, etc. Each set of three measurements of the swelling in the three liquids is therefore to be considered separately, and is not to be compared with one above or below, either as to amplitude or relative swelling, as the experiments were varied in many ways. For the sake of completeness some results with agar and with gelatine alone are included.

Gelatine

Sodium Hydrate (Hundredth Normal)	Hydrochloric Acid (Hundreth Normal)	Distilled Water
280%	560%	250%
125	283	125
	Gelatine 100—Agar 1	
750	1,100	520
	Gelatine 100—Agar 5	
667	767	325
704	933	333
	Gelatine 80—Agar 20	
800	700	425
875	775	—
600	900	—
850	650	558
600	600	275
900	1,000	600
700	900	300
	Gelatine 50—Agar 50	
788	788	692
500	333	1,133
600	350	525
675	225	—
400	350	500
600	200	700
450	300	875
633	367	1,167
	Gelatine 20—Agar 80	
600	400	1,150
600	600	1,450
600	700	1,200
450	700	1,150
433	533	767
600	500	1,200
	Agar	
400	650	775
525	800	1,100

The outstanding fact that a mixture consisting mostly of gelatine, to which a small proportion of agar has been added, shows its greatest swelling in alkaline solutions is the most important feature of these results. The mixture in question is available as a physical analogue which has already been found useful in the study of growth and swelling of plants.

The data of the table indicate that as the percentage of agar in the gelatine is increased the mixture swells more in distilled water and less in acid or alkali, thus approaching the behavior of pure agar. Concerning the relative effects of acid and alkali, assured conclusions are not now possible but the data suggest that acid tends to increase imbibition at the ends of the series, that is as pure agar and pure gelatine are approached, while alkali tends to increase it in the middle mixtures containing the two colloids in more nearly equal proportions.

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THE THEORY OF AUTONOMOUS FOLDING IN EMBRYOGENESIS[1]

THE experiments of Roux,[2] carried out on the embryonic chick, prove conclusively that the folding of a neural plate into a neural tube is not dependent, as His[3] had supposed, on the mechanical effect of one tissue upon another, but is autonomous. Self-differentiation in this instance is identical with self-folding. The question therefore arises: How can the neural plate fold itself?

Our reply must necessarily bear on all cases of autonomous folding, and reciprocally any one of them might serve as the basis for this analysis. The nervous system, however, is by far the largest, most easily studied, and, in addition, the most familiar of all the embryonic tissues in which self-folding occurs. Moreover, in its simpler forms, it indicates so clearly the direction in which an explanation of its autonomous transformations is to be sought, that for the present it seems best to limit the discussion to what may be justified as a type case.

For our immediate purposes, the neural plate of *Cryptobranchus allegheniensis* is especially suitable. Not only is it unusually large, as neural plates go, but wherever cell-boundaries are distinct, it is, without question, unicellular in thickness. The first problem to be solved is the rôle of cell-multiplication.

In a neural plate in which the cells are irregular in position and dovetailed into one another as they are in crowded columnar epithelia, inequalities in the rate of division and protoplasmic synthesis at or near the two surfaces might lead to folding, but in the *Cryptobranchus* embryo, in which the plate is partly syncytial and in which the visible cell-walls are continuous from one surface to the other, and remain so during the entire period of folding, it is difficult to conceive how cell-multiplication could result in anything except uniform enlargement. The exclusion of this factor from participation in the process of involution, however, does not depend on mere argumentation, for comparison of the number of nuclei in comparable regions of the flat, half-folded, and completely folded plate, shows that the number of cells per section actually does not increase[4] (Table I.). Indeed in less simple material, such as the neural plate of the mammal, in which the number of cells does increase during folding, the restriction of the mitoses to the concave surface must, if effective at all, exert a force opposed to the forces that bring about the curvature. In this instance,

TABLE I

Number of Nuclei in Comparable Sections

Stage I, Flat	Stage II, Half-folded	Stage III, Folded
63	56	55
53	64	60
58	50	73
69	56	47
72	50	69
58	82	59
59	70	64
58	74	51
58	58	52
68	51	55
Ave. 62	61	59

[1] Read at the joint meeting of the American Society of Zoologists and Section F of the American Association for the Advancement of Science, in Columbus, December, 1915.

[2] "Die Entwicklungsmechanik," W. Engelmann, Heft 1, Leipzig, 1905.

[3] "Unsere Körperform, und das Physiologische Problem Ihrer Entstehung," F. C. W. Vogel, Leipzig, 1874.

[4] For the validity of these comparisons see Glaser, *Anatomical Record*, Vol. 8, pp. 528–530.

therefore, a neural plate folds *in spite of* an increase in the number of its constituent cells.

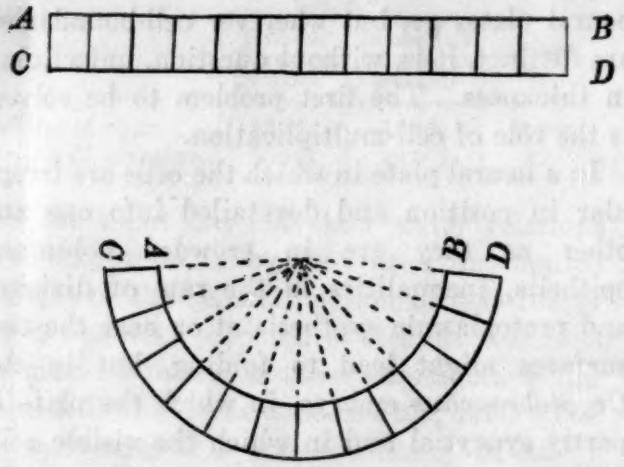

FIG. 1. Diagrammatic representation of a neural plate *A B C D*, conceived of, for the sake of simplicity, as entirely flat and made up of one layer of rectangular cells. The lower half of the figure shows the same plate symmetrically folded, its upper and under sides having become the outlines of two concentric circles. With the cells constant in number and position, the line *A B* is now necessarily shorter than the line *C D*.

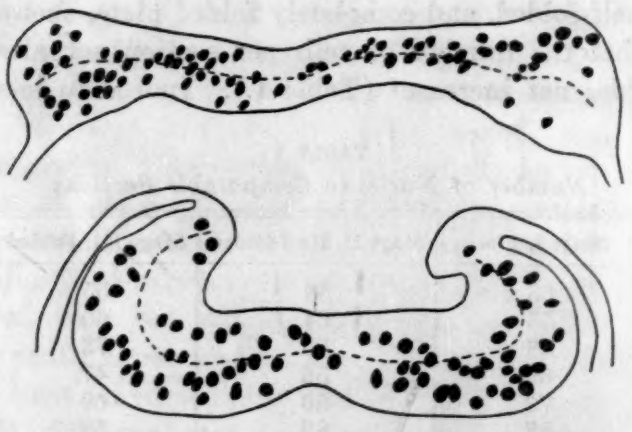

FIG. 2. Two sections through the embryonic nervous system of *Cryptobranchus allegheniensis*, showing the nuclear distribution in Stages I. and II. The sections are from the same series and regions as those dealt with in the tables but contain for Stage I., six, and for Stage II., one nucleus more than the maximal number recorded in Table I. In the unfolded plate there are in the present case, 78 nuclei, of which 47 are in the upper half above the dotted line, and 31 in the lower; in the half-folded plate, there are 75 nuclei, 21 in the upper zone, and 54 in the lower. Nuclei which happen to fall on the line separating the two zones are ascribed to the one into which the greater portion of their mass projects.

The only remaining way in which a neural plate can fold itself is by a rearrangement of materials present at the beginning. In this connection the most patent fact, emphasized long ago by Rhumbler[5] and Conklin[6] in their studies of invaginate gastrulation, is a change in the shape of the cells whose sectional outlines alter from the rectangular form to that of a trapezium (Fig. 1). This geometrical transformation, which might be forced upon the cells from without, necessarily has the same result when autonomously produced, for it involves lengthening of one surface, shortening of the other, and a redistribution of the cell-contents. The extent of the latter, as indicated by the migration of nuclei from the side becoming concave to that becoming convex, is clearly shown for two sections in Fig. 2, and for a series, in Table II.

TABLE II

Distribution of Nuclei in Upper and Lower and Inner and Outer Zones

Stage I, Flat		Stage II. Half-folded		Stage III, Folded	
Upper	Lower	Upper	Lower	Inner	Outer
32	31	31	25	15	40
32	21	22	42	15	45
34	24	16	34	21	52
55	14	27	29	13	34
39	33	18	32	22	47
38	20	27	55	16	43
31	28	33	37	26	38
33	25	29	45	13	38
37	21	21	37	20	32
44	24	19	32	20	35
Ave. 38	24	24	37	18	39

According to this, the distribution of the nuclei is not only completely reversed during folding, but the final relation between the number in what become the inner and outer zones, respectively, of the definitive tube, is as 2 to 1. Provided only that the nervous system is, by its structure and relations, incapable of indefinite expansion, these changes are all that are required to bring about the folding.

[5] "Zur Mechanik des Gastrulationsvorganges," *Arch. f. Entwicklungsmech.*, Bd. 14.

[6] "Mosaic Development in Ascidian Eggs," *Jour. Exp. Zool.*, Vol. 2, p. 163.

In my attempt to gain some insight into the manner in which these changes might be effected in the absence of coercion from without, I determined, at constant magnification, the areas of comparable sections during the process of involution. The marked relative increases shown in Table III. were found.[7]

TABLE III

Relative Areas of Comparable Sections

Stage I, Flat	Stage II, Half-folded	Stage III, Folded
9.4 cm.²	13.7 cm.²	17.5 cm.²
8.1	11.3	19.5
10.6	11.4	19.5
9.9	10.1	20.6
9.1	10.1	20.5
9.6	10.9	18.1
9.1	11.5	19.0
8.2	12.0	18.5
8.3	10.2	18.9
9.9	10.1	18.8
Ave. 9.2	11.1	19.1

This increase in area indicates growth in volume, and can be the result only of enlargement on the part of the individual cells constituting the nervous system. The immediate problem is obvious.

In Table IV. are given the water-content as well as the distribution of water in the larvæ of *Rana pipiens* and *Amblystoma punctatum*, four to five days after fertilization.

Since the period of differentiation under discussion has been completed at the stage of development considered in the table, and since this differentiation includes folding, and folding is associated with enlargement, it follows that the differential absorption of water by the nervous system probably took place during the process of involution. As the results show, the water-content rises to a point practically identical with the figure 80.5 per cent. given by Donaldson for the cord of the adult *R. pipiens*.[8]

[7] For details concerning the distribution of this increase within the sections themselves, see Glaser, *loc. cit.*, pp. 530–533.

[8] Donaldson, Henry H., "Further Observations on the Nervous System of the American Leopard Frog, etc.," *Jour. Comp. Neurol.*, Vol. 20. Also earlier papers.

TABLE IV

Water Content and Distribution of Water in Embryos of Rana pipiens and Amblystoma punctatum Four to Five Days after Fertilization

Material	Fresh Weight, Grams	Dry Weight, Grams	Dry Substance, Per Cent.	Water, Per Cent.
R. pipiens:				
38 larvæ	0.1278	0.0557	43.6	56.4
50 larvæ	0.1718	0.0722	42.0	58.0
39 larvæ	0.1815	0.0730	40.2	59.8
41 larvæ	0.1788	0.0733	41.0	59.0
Average			**41.7**	**58.3**
24 yolk-sacs	0.0440	0.0204	46.5	53.5
31 yolk-sacs	0.0585	0.0264	45.1	54.9
Average			**45.8**	**54.2**
24 nervous systems	0.0464	0.0098	21.1	78.9
31 nervous systems	0.0714	0.0149	20.9	79.1
50 nervous systems	0.0916	0.0185	20.2	79.8
Average			**20.7**	**79.2**
A. punctatum:				
16 larvæ	0.0955	0.0399	41.8	58.2
15 larvæ	0.0992	0.0406	40.9	59.1
Average			**41.4**	**58.6**
125 nervous systems	0.3914	0.0785	19.9	80.1
52 nervous systems	0.1756	0.0400	22.8	77.2
15 nervous systems	0.0524	0.0106	20.2	79.8
69 nervous systems	0.2039	0.0363	17.8	82.2
Average			**20.2**	**79.8**

But this absorption of water can only account for the enlargement of the nervous system, not at all for its folding.

To explain this in complete harmony with all the known facts, only one assumption is necessary. The neural plate is exposed to an external environment, whose constancy, within the limits under which normal development takes place at all, is very high. Laterally each cell of the plate is bounded by a chemical system fundamentally like itself. Disturbances of equilibrium on any one of these surfaces are relatively unlikely. However, on its under side, the plate is subjected to a constant change of conditions due to the multitude of processes going on within the rest of the embryo. To mention only one factor, there is a distinct increase in the acidity of the internal medium.

On this basis we may interpret the absorp-

tion of water as the result of a change in those surfaces of the absorbent cells which are exposed to the inconstant intra-embryonic environment. If this change involves a weakening of the face of the neural plate that becomes convex, the curvature that leads to the formation of a tube would be accounted for.[9]

Accordingly then, the absorption of water is not the cause of folding, but a symptom of that cause. If this interpretation is correct, the water content of the cells at any given level in the early stages of involution can not be uniform. In fact the theory demands that the marginal cells of the neural plate, the first, it will be recalled, to undergo a change of shape, shall have a higher water-content than the cells in the middle of the plate which only assume the wedge-shape during the last stages of involution.

For the decision of this crucial question, no direct method is as yet available. However, it is possible to secure evidence indirectly which seems to me convincing.

If the eggs of the starfish are placed in hypotonic sea-water, and given an opportunity to absorb more water than they normally contain, they at once increase in volume, and their nuclei, easy to deal with on account of their spherical shape, also enlarge. The facts on which this statement is based are given in Table V.

TABLE V

Asterias Eggs in Various Concentrations of Sea-water

No. of Eggs	Conc. Sea Water	Conc. Dist. Water	Diam. Eggs	Diam. Nuclei
18	100%	0%	142μ	.68μ
	66	34	170	.82
23	100	0	138	.66
	75	25	144	.70
47	100	0	152	.66
	60	40	188	.82
49	100	0	154	.66
	60	40	170	.80

[9] For the relation between this view and the Rhumbler Surface-Tension Hypothesis, as well as for a criticism of the latter, see Glaser, *loc. cit.*, pp. 536–548.

Before applying this information to the problem in hand, I had first of all to determine whether these facts held for the nervous system, and especially whether measurable differences could be demonstrated in those regions known to have contained during life, different proportions of water.[10]

TABLE VI

Relative Water Contents of Embryonic Cords and Brains

	Embryonic Cords		Embryonic Brains
Amblystoma	125	>	125 by 2.2 per cent.
Rana	139	>	135 by 1.9 per cent.
Rana	192	>	188 by 2.3 per cent.

Relative Sizes of Nuclei

Nervous System of *Cryptobranchus Embryos*

Stage I			Stage II			Stage III		
Cord	Brain	Ratio	Cord	Brain	Ratio	Cord	Brain	Ratio
109	109	1:1.2	126	114	1:1.1	125	113	1:1.3
119	114	1:1.2	107	108	1:1.1	143	123	1:1.2
120	125	1:1.1	127	129	1:1.2	133	113	1:1.3
121	119	1:1.1				115	131	1:1.3

Control 36-hour Chick

End of Cord	Forebrain	Ratio
110	124	1:1.4

Relative Sizes of Nuclei in Center and at Edges of Neural Plate in Cryptobranchus during Folding

Number and Positions of Nuclei

Central	Lateral	Ratio
110	115	1:1.2
112	120	1:1.2
112	111	1:1.1
135	122	1:1.2

In both *Amblystoma punctatum* and *Rana pipiens* (Table VI.), a comparison of the anterior and posterior ends of the embryonic nervous systems, indicates a higher water-content in the larval brain than in the cord. Since these results are consistent, and, in sense, agree with corresponding differences found by Donaldson (*loc. cit.*) for the adult nervous system of *Rana pipiens*, I feel fairly certain of the essential correctness of my values, and

[10] That the embryonic brain has a higher water content than the cord is indicated by the figures which I published in Science, N. S., Vol. XXXIX., pp. 730–731, in 1914. The evidence there presented was meager and, unfortunately, I overlooked some arithmetical errors. Recalculation has made no essential difference in the results, however, and further evidence now shows them to have been essentially correct.

infer, therefore, that the embryonic brain, like that of the adult, also has a water-content higher than that of the cord at the same age.

If this is indeed correct, and, moreover, if nuclear volume varies with the water-content of the cell, and, furthermore, if fixation does not destroy or completely reverse the volumetric relations, one would expect the nuclei in the anterior end of an embryonic nervous system to be larger than those in the posterior.

In *Cryptobranchus* embryos such comparisons are easily made. The nuclei are large so that errors, inevitably committed in determining their volumes, are relatively small. Certain precautions however are essential. Thus nuclei in various stages of mitosis must obviously be excluded. Also, since the resting nucleus is ovoid in shape, it is necessary to consider only those similarly oriented with reference to the plane of section. Absolute volumes are, of course, not practicable, nor are they requisite. All that the theory demands is that the average size of the nuclear sections in the regions which had the higher water-content shall be greater than those in the regions in which the water-content was lower. Tracings of some 2,800 nuclei whose outlines on paper were cut out with scissors and weighed under uniform conditions of atmospheric moisture, give results remarkable for their uniformity.

The absolute regularity of the ratios based on *Cryptobranchus,* and on the control observation on the thirty-six hour chick, convinced me that nuclear size, even in preserved materials, can be utilized as an index of original water-content. If now, the absorption of water is itself an index to the surface alteration to which I attribute the change in shape undergone by the cells during involution, then the nuclei of the lateral curling edges in any given section should on the average be larger than those in the, as yet, unfolded center. This, as indicated in the last division of Table VI., is true for *Cryptobranchus.*

Since this expectation has been fulfilled, I feel that the problems involved in the autonomous folding of the nervous system, and by implication, also involved in such other autonomous foldings as that of the entodermal plate in typical invaginate gastrulation, have begun to merge with the physical-chemistry of the tissues concerned, and the conditions to which their constituent cells are subjected at various periods of development.

O. C. GLASER

UNIVERSITY OF MICHIGAN

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-third summer meeting and eighth colloquium of the society were held at Harvard University during the week September 4–8, 1916. Monday and Tuesday were devoted to the summer meeting proper, two sessions being held on each day for the presentation and discussion of papers. The colloquium opened on Wednesday morning and extended to Friday afternoon. Courses of lectures were given by Professor G. C. Evans, of Rice Institute, on "Topics from the theory and applications of functionals, including integral equations," and Professor Oswald Veblen, of Princeton University, on "Analysis situs."

Ninety-nine were in attendance. President E. W. Brown occupied the chair, being relieved by Vice-presidents E. R. Hedrick and Virgil Snyder. The council announced the election of the following persons to membership in the society: Mr. Herman Betz, Cornell University; Mr. J. A. Bigbee, High School, Little Rock, Ark.; Mr. Hillel Halperin, Vanderbilt University; Dr. J. R. Kline, University of Pennsylvania; Professor J. J. Luck, University of Virginia; Dr. F. J. McMackin, Dartmouth College. Seven applications for membership in the society were received.

Through the generosity of Harvard University the freshman dormitories and dining room were thrown open for the use of the society during the meeting. On Monday noon the members were shown the collection of mathematical models belonging to the university. On Wednesday afternoon a visit was paid to the university library, and on Wednesday evening to the observatory. Resolutions were adopted at the meeting expressing the thanks of the society for the hospitality of the university and its officers.

Fraternal greetings were exchanged by cable with the Scandinavian mathematicians assembled at Stockholm. A vote of congratulation was tendered to the secretary on his twenty-first year of service in that capacity.

The twenty-fifth anniversary of the broadening out of the society into a national organization and the founding of the *Bulletin* were celebrated at the banquet on Monday evening, at which eighty-four members and friends were present. Brief addresses were made by Professors Fiske, W. W. Johnson, Fine, Birkhoff, Hedrick, Webster, Coolidge and the secretary.

On Tuesday evening Professor D. E. Smith entertained the society with an interesting account of "The relation of the history of economics to the history of arithmetic problems."

The following papers were read at the summer meeting:

J. C. Fields: "Direct derivation of the complementary theorem."

C. A. Fischer: "Note on the order of continuity of functions of lines."

Olive C. Hazlett: "On the theory of associative division algebras."

W. C. Eells: "A statistical study of eminent mathematicians."

J. L. Coolidge: "The characteristic numbers of real algebraic plane curves."

R. W. Burgess: "The comparison of a certain case of the elastic curve with its approximation."

G. A. Miller: "Orders of operators of congruence groups modulo $2^r\ 3^s$."

John Eiesland: "Sphere geometry (third paper)."

A. J. Kempner: "Generalization of a theorem on transcendental numbers."

C. N. Moore: "On the developments in Bessel's functions."

Arnold Dresden: "Supplementary note on the second derivatives of an extremal integral."

L. E. Dickson: "Extension of the theory of numbers to the rational numbers of certain sets."

A. G. Webster: "On a theory of acoustic horns."

E. H. Moore: "On properly positive Hermitian matrices."

L. P. Eisenhart: "Deformations of transformations of Ribaucour."

F. R. Sharpe and Virgil Snyder: "On (2—2) point correspondence between two planes."

F. H. Safford: "Surfaces of revolution in the theory of Lamé's products."

Dunham Jackson: "Note on the parametric representation of an arbitrary continuous curve."

Dunham Jackson: "Note on representations of the partial sum of a Fourier series."

L. H. Rice: "Determinants of many dimensions."

L. R. Ford: "Regular continued fractions."

M. W. Haskell: "The eliminant of a system of forms."

E. V. Huntington: "A simple substitute for Duhamel's theorem."

E. V. Huntington and J. R. Kline: "Sets of independent postulates for betweenness."

G. D. Birkhoff: "Dynamical systems with two degrees of freedom (second paper)."

E. B. Van Vleck: "Non-loxodromic substitutions in n variables."

L. I. Hewes: "Nomograms of adjustment."

H. C. M. Morse: "A theorem on the linear dependence of analytic functions of a single variable."

G. A. Pfeiffer: "Note on the linear dependence of analytic functions."

G. M. Green: "On the linear dependence of functions of one variable."

C. L. Bouton: "Iteration and group theory."

G. M. Green: "On the general theory of surfaces."

W. V. Garretson: "On the asymptotic solution of the non-homogenous linear differential equation of the nth order. A particular solution."

Caroline E. Seely: "On series of biorthogonal functions."

A. B. Frizell: "Lemma for a new method of generating alephs."

John Eiesland: "Transformation theory of the flat complex and its associated line complex."

A. R. Schweitzer: "On the type of quasi-transitive functional equations (second paper)."

A. R. Schweitzer: "A problem in quasi-transitive functional equations."

A. R. Schweitzer: "Some theorems on quasi-transitive functional equations."

A. R. Schweitzer: "On the analogy between functional equations and geometric order relations."

T. H. Gronwall: "On the power series for log $(1+z)$."

T. H. Gronwall: "A problem in geometry connected with the analytic continuation of a power series."

T. H. Gronwall: "On the convergence of Binet's factorial series for log $\Gamma(z)$ and $\psi(z)$."

T. H. Gronwall: "On the zeroes of the function $\beta(z)$ associated with the gamma function."

The next meeting of the society will be held at Columbia University on Saturday, October 28. The Southwestern Section will meet at the University of Kansas on Saturday, December 2.

F. N. Cole,
Secretary